Ground-Water Data for the Drewsey Resource Area, Harney and Malheur Counties, Oregon

U.S. GEOLOGICAL SURVEY
Open-File Report 77-741

Prepared in cooperation with the
U.S. Bureau of Land Management

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By J. B. Gonthier, C. A. Collins, and D. B. Anderson

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Portland, Oregon
September 1977

UNITED STATES DEPARTMENT OF THE INTERIOR
Cecil D. Andrus, Secretary

GEOLOGICAL SURVEY
Vincent E. McKelvey, Director

For additional information write to:

U.S. Geological Survey
P.O. Box 3202
Portland, Oregon 97208

CONTENTS

ILLUSTRATIONS

TABLES

FACTORS FOR CONVERTING ENGLISH UNITS TO INTERNATIONAL SYSTEM UNITS (SI)

For use of those readers who may prefer to use metric units rather than English units, the conversion factors for the terms used in this report are listed below:

Multiply English units	By	To obtain metric units
Length		
feet (ft)	0.3048	meters (m)
inches (in)	25.4	millimeters (mm)
miles (mi)	1.609	kilometers (km)
Area		
acres	.4047	hectares (ha)
square miles (mi^2)	2.590	square kilometers (km^2)
Volume		
acre-feet (acre-ft)	1233	cubic meters (m^3)
acre-feet (acre-ft)	.001233	cubic hectometers (hm^3)
cubic feet (ft^3)	.02832	cubic meters (m^3)
gallons (gal)	3.785	liters (L)
Mgal (million gallons)	3785	cubic meters (m^3)
Specific combinations		
cubic feet per second (ft^3/s)	.02832	cubic meters per second (m^3/s)
gallons per minute (gal/min)	.06309	liters per second (L/s)
gallons per minute per foot [(gal/min)/ft]	.2070	liters per second per meter [(L/s)/m]
million gallons per day (Mgal/d)	3785	cubic meters per day (m^3/d)
Temperature		
degrees Fahrenheit (°F)	5/9 after subtracting 32 from F° value	degrees Celsius (°C)

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INTRODUCTION

Appraisals of the resources of selected management areas in eastern Oregon are being made by the U.S. Bureau of Land Management. To provide needed hydrologic information the Bureau of Land Management requested the U.S. Geological Survey Water Resources Division to inventory ground-water data for the Drewsey Resource Area. The inventory included field location of selected wells and springs, measurement of ground-water levels, ground-water temperatures, specific electrical conductance, pH, and collection of ground-water samples at selected localities to determine dissolved chemical constituents.

Included in this data report are well data, drillers' lithologic logs, hydrographs, a summary of observation-well data, and chemical analyses of ground water.

Previous Investigations

Parts of the Drewsey Resource Area are included in previous studies of the geology and ground-water resources of the Harney Basin (Waring, 1909; Piper and others, 1939; and Leonard, 1970). Leonard's report describes the occurrence, distribution, availability, and chemical quality of ground water in the Harney Valley. The area covered by that report is outlined on plate 1, and within that area, no new data have been collected for this report. The Harney Valley report (Leonard, 1970) could serve as a basis for interpretation and evaluation of data presented in this report. A report by Hubbard (1975) describes the surface-water resources of the Harney Valley and includes a detailed water budget for Malheur Lake. Geologic information for the resource area is shown on the "Geologic Map of the Burns Quadrangle, Oregon" (Greene and others, 1972).

Hydrographs of representative wells in Oregon appear in annual reports prepared by the Oregon Water Resources Department (formerly the State Engineer's Office) (Sceva, 1964; Sceva and DeBow, 1965, 1966; Bartholomew and DeBow, 1967, 1970; Bartholomew and others, 1973).

Location and Description of the Area

The Drewsey Resource Area is located in eastern Oregon. Most of the area is in northeastern Harney County, but a small part of Malheur County is also included (fig. 1). The boundary of the Drewsey Resource Area has been established by the Bureau of Land Management, and it does not conform either with

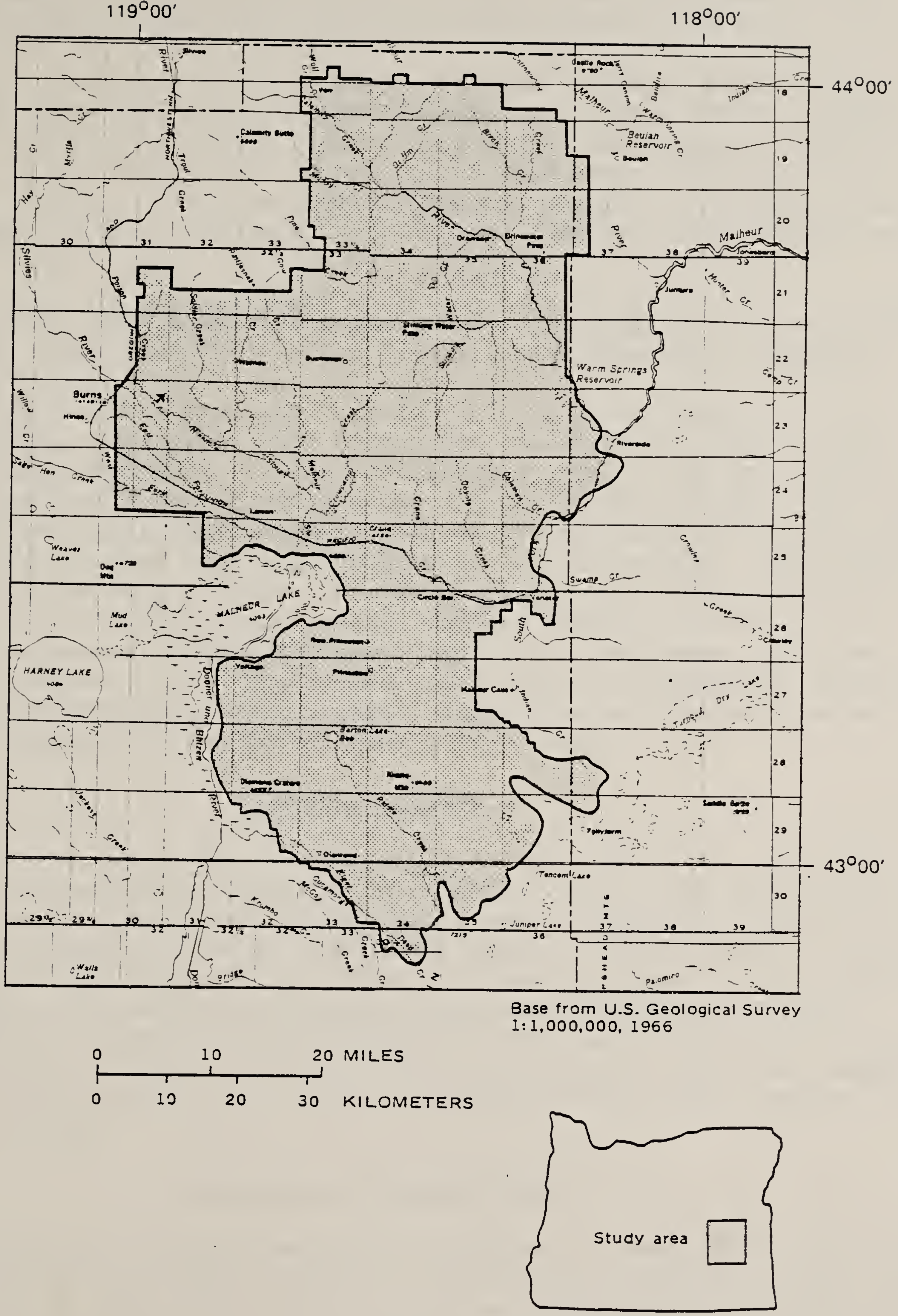

Figure 1.—Map showing location and general features of the Drewsey Resource Area, Oregon.

natural, physical, or established political boundaries; it is, however, a land unit within the Bureau of Land Management, Burns District. Land within the Drewsey Resource Area is in both private and public ownership, and a large part is held in public trust by the Bureau of Land Management. The total area included in the Drewsey Resource Area exceeds 2,500 mi^2.

The cities of Burns and Hines, Oreg., with an estimated combined population of 5,170 persons in 1976 (Oregon Secretary of State, 1977) are near the northwest edge of the resource area. The population density of the resource area is greatest in the Harney Valley near Burns and Hines; elsewhere it is extremely small. Small settlements include Drewsey, and Buchanan in the north, and Lawen, Crane, Princeton, Voltage, and Diamond in the central and south.

Good highways cross part of the study area, but much of it is accessible only during the summer and fall months by using four-wheel-drive vehicles.

The Drewsey Resource Area includes most of the Harney Valley, a flat, featureless plain, and uplands that border the valley on the north, east, and south. The Steens Mountains, in the southeastern part of the area, attain an altitude of more than 9,000 ft and are the highest of the uplands. The Harney Valley is a closed basin, and streams draining the bordering hills discharge into Malheur Lake located near the south center of the valley. The principal streams entering the Harney Valley are the Silvies River, which drains the upland north of the Drewsey Resource Area and the Donner und Blitzen River which drains the western ramplike slope of the Steens Mountains and flows northward into Malheur Lake. The Malheur River and its tributaries drain the uplands in the northern and eastern parts of the Drewsey Resource Area and ultimately discharge into the Snake River to the east.

General Geology

The uplands bordering the Harney Valley consist of volcanic and pyroclastic rocks and sediments derived from volcanic rocks. The uplands are cut by numerous faults, and the rock strata slope gently toward the Harney Valley, which is both an erosional and a structural basin. Unconsolidated valley-fill deposits underlie the Harney Valley floor to a maximum depth of about 250 ft (Leonard, 1970). The valley-fill deposits consist chiefly of clay, but contain lenticular deposits of sand and gravel in alluvial fans built by the principal streams. Beneath the valley-fill deposits are a large but unknown thickness of consolidated rocks similar in composition to those exposed in the bordering uplands.

Occurrence of Ground Water

Large quantities of ground water are withdrawn by numerous wells from sand and gravel and from consolidated rock aquifers in the Harney Valley east of Burns. Wells in that area produce as much as several hundred gallons of water per minute, and the water is used chiefly for irrigation. The distribution of the consolidated rock aquifers beneath the valley-fill deposits is generally poorly known. Ground water in the Harney Valley is generally confined beneath beds of clay or other rocks of low hydraulic conductivity such

as welded tuff or dense crystalline basalt. Locally, ground water in shallow sand and gravel aquifers is unconfined.

Ground-water recharge in the uplands is chiefly by direct infiltration of precipitation, and locally along streams by infiltration of streamflow during periods of high runoff. Each spring, snowmelt runoff from upland streams floods large areas of the Harney Valley floor and recharges the valley-fill deposits. Upward movement of ground water from the underlying consolidated rocks also provides small quantities of recharge to the valley-fill deposits.

The general direction of movement of ground water in the Drewsey Resource Area is from upland recharge areas toward valley areas where the ground water is discharged by seepage to springs, by diffuse seepage to streams, by evapotranspiration, or by wells. In the Harney Valley, ground water in the valley-fill deposits is moving toward Malheur Lake. Most of this ground water is discharged in the valley by direct evapotranspiration of shallow ground water before it reaches Malheur Lake. Evapotranspiration of shallow ground water probably is the cause of large areas of alkali soil in the valley.

Locally in the Harney Valley, wells and springs yield warm geothermally heated ground water; some of these occurrences are described by Leonard (1970). Two warm springs outside the Harney Valley were visited during this study, and the data are listed in the accompanying tables.

EXPLANATION OF DATA

Well- and Spring-Numbering System

Wells and springs are assigned a number based on their location according to the rectangular system for subdivision of public lands. In successive order, the numerals represent the township, range, and section. Thus, well 25S/36E-16ccc is in township 25 south, range 36 east, section 16. The letters following the section number show the location within the section, the first letter designating the quarter section (160 acres), the second letter the quarter-quarter section (40 acres), and the third letter the quarter-quarter-quarter section (10 acres). Where two or more wells are in the same 10-acre subdivision, serial numbers are added after the third letter, as shown in figure 2. For a spring, a lower case (s) in parentheses is appended to the number as described.

Records of Wells and Springs

Records for 88 wells and springs in the Drewsey Resource Area outside that area studied by Leonard (1970) are listed in table 1. Well records for the Harney Valley are included in Leonard's (1970) report. Most of the wells for which drillers' reports were available have been field located; their locations are shown on plate 1. Most of these well locations are also plotted on Geological Survey 1:24,000-scale quadrangle maps, and these field maps are on file in the Geological Survey Oregon District Office. Table 1 also includes some data on selected springs; wherever possible the discharge of the

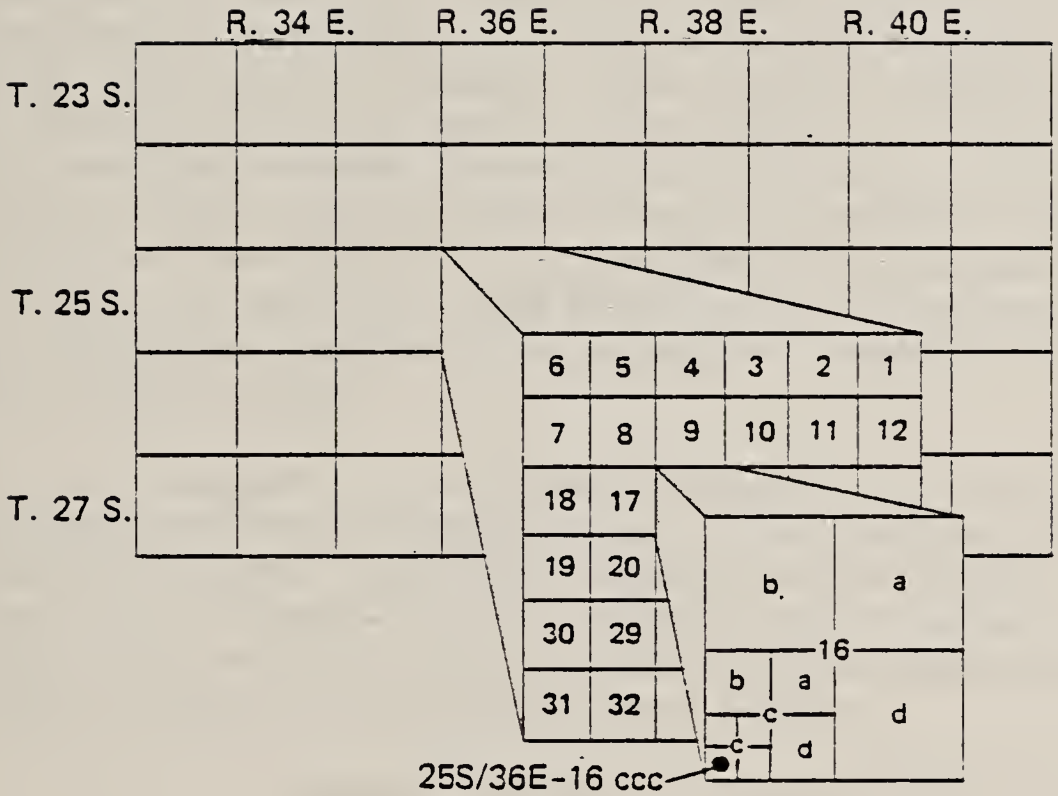

Figure 2. – Well-numbering system

spring was measured at the time of the visit. Little or no data were available, however, for estimating the annual range of discharge of each spring.

Drillers' Logs of Wells

Drillers' logs of wells are obtained from reports submitted by drillers to the Oregon Water Resources Department since 1956 and from records supplied by the Bureau of Land Management. Drillers' terminology for the materials penetrated vary from driller to driller. Therefore, the logs in table 2 have been edited for consistency, but they otherwise remain unchanged.

Hydrographs of Observation Wells

Hydrographs in figure 3 show fluctuations of ground-water levels in four representative observation wells in the Drewsey Resource Area. The period of record for two of the wells extends from 1928 and 1930 to the present, and the other two are for shorter periods. Ground-water levels generally rise each year when the ground-water reservoir is recharged and ground-water storage is increased. Water levels decline during periods of no recharge as ground-water storage decreases. If over a period of time, ground-water discharge exceeds the rate of recharge, water levels gradually decline and the hydrographs show a declining trend. Conversely, a rising trend occurs when ground-water recharge exceeds ground-water discharge. In most of the Drewsey Resource Area no rises nor declining trends are apparent and ground-water levels are more or less stable. This suggests that ground-water recharge and discharge in the area generally are in balance. Ground-water pumpage in some of the area near Burns, however, is gradually increasing and some observation wells show declining trends.

Table 4 is a summary of the observation-well data for 35 wells in the Drewsey Resource Area and bordering area. The locations of the observation wells are shown on plate 1, and well records are in table 1 in this report or in the report by Leonard (1970). Hydrographs of water levels for each observation well are available from the Oregon Water Resources Department or from the Oregon District of the Geological Survey.

Chemical Quality of Ground Water

Chemical analyses were made by the Geological Survey of 16 ground-water samples from the Drewsey Resource Area. The source and significance of the chemical constituents and physical properties are summarized in table 4, and the analyses are listed in table 5.

Chemical diagrams for each analysis are shown on plate 1. The scale of the diagrams is similar to those presented in Leonard's report (1970); therefore, a visual comparison of the areal variation of the chemical quality of the ground water is possible.

Data from table 4 are plotted on a salinity diagram (fig. 4) which shows the classification of the ground water for irrigation use.

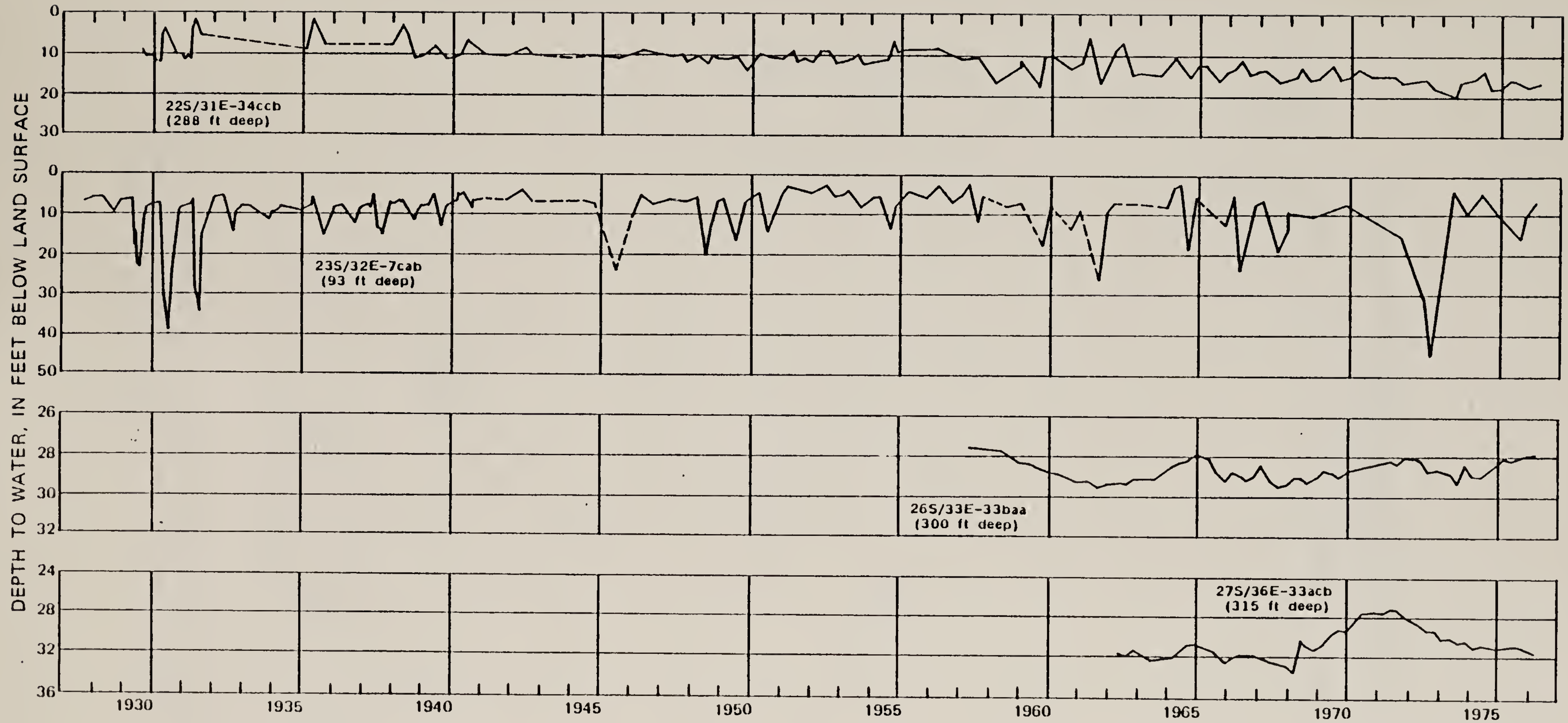

Figure 3. — Hydrographs of selected observation wells.

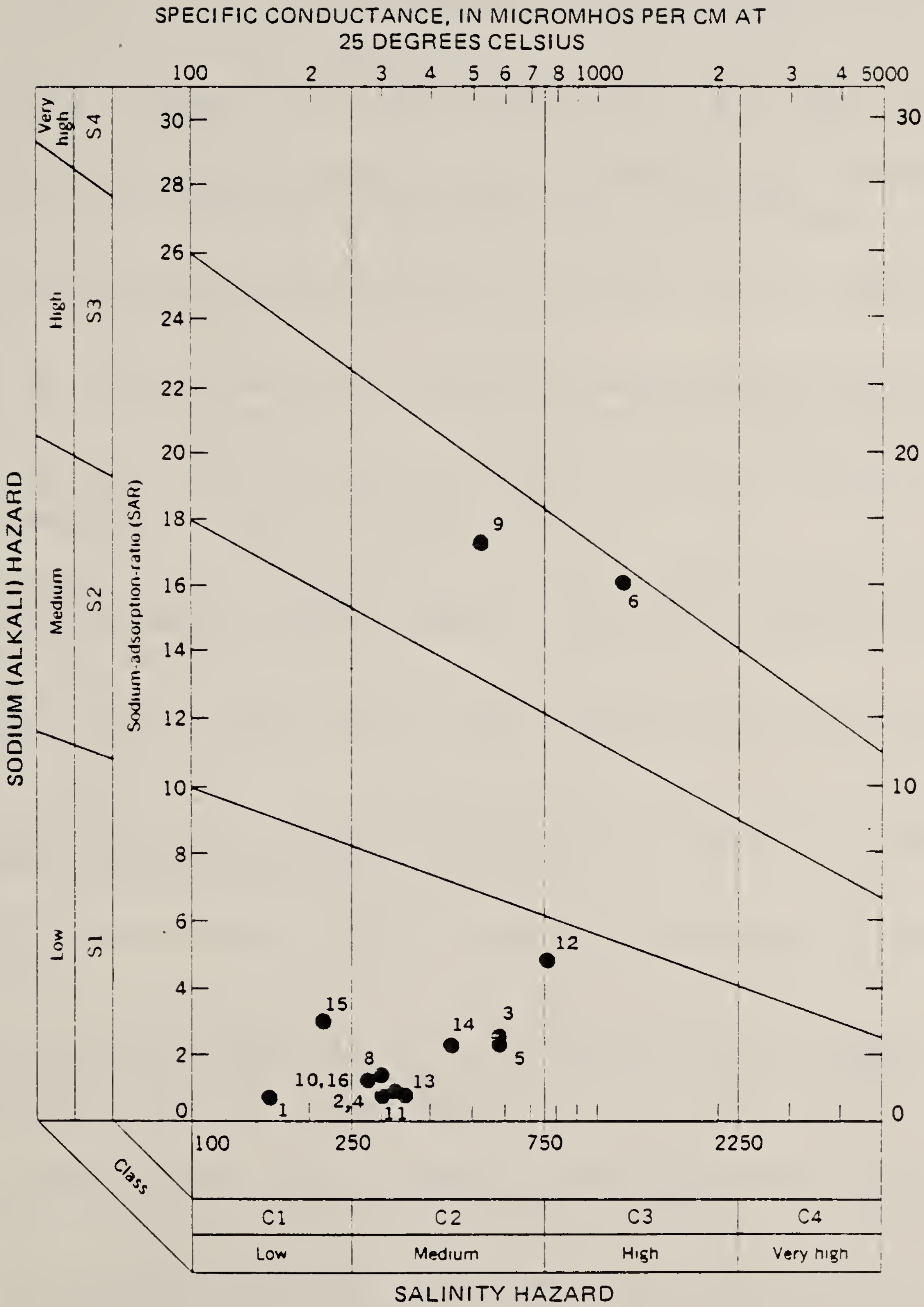

Figure 4. — Classification of irrigation waters. Numbers of plotted circles correspond to sample numbers in table 5. Sample number 7 plots off the upper and of the diagram.

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GLOSSARY OF SELECTED TERMS

Aquifer.--A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells or springs.

Confined ground water.--Ground water that is under pressure significantly greater than atmospheric. In a well that taps a confined ground-water body, the static water level is above the top of the aquifer.

Drawdown.--The lowering of ground-water level caused by pumping. It is the difference, generally, in feet or meters, between the static water level and the pumping water level in a well.

Evapotranspiration.--Water withdrawn from a land area by evaporation from water surfaces and moist soil and by plant transpiration.

Hydraulic conductivity.--The volume of water that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow.

Hydraulic gradient.--The change in static head per unit of distance in a given direction. The direction generally is understood to be that of the maximum rate of decrease in head.

Intermittent (or seasonal) stream.--A stream that flows only at certain times of the year when it receives water from springs or from some surface source such as melting snow in mountainous areas.

Perched ground water.--Unconfined ground water separated from an underlying body of ground water by an unsaturated zone.

Perennial stream.--A stream that flows continuously.

Potentiometric surface.--A surface that represents the static head. In an aquifer it is defined by the levels at which water stands in tightly cased wells.

Runoff.--That part of the precipitation that appears in surface streams.

Specific capacity.--The rate of discharge of water in a well divided by the drawdown of water level within the well. It is an approximate index of the capability of an aquifer to transmit water.

Static head.--The height above a datum (mean sea level) of the surface of a column of water in a well. The terms "head" and "static water level" are used interchangeably in this report. The static water level in a well represents the average head of the water-bearing materials open to the well bore.

Unconfined ground water.--Ground water in an aquifer that has a water table.

Water table.--The potentiometric surface in an unconfined water body at which the pressure is atmospheric.

Table 1.--Records of selected wells and springs in the Drewsey Resource Area

Well number: See page 7 for description of well- and spring-numbering system.
Type of well: Dr, drilled.
Depth of casing: Depth of casing indicates total length of casing.
Finish: P, perforated; X, open hole.
Character of material: Character of material refers to water-bearing formations as reported by driller.
Altitude: Altitude of land surface at well, in feet above mean sea level, interpolated from topographic maps, generally to the nearest 1 foot.
Water level: Depths to water below land surface given in feet and decimals were measured by personnel of the Geological Survey or the Oregon Water Resources Department; those given in whole feet were reported by well driller or owner.
Specific conductance: Field measurements by Geological Survey personnel. Units used: micromhos per centimeter at 25°C.

pH: See table 4 for explanation of pH.
Type of pump: C, centrifugal; J, jet; N, none; P, piston; S, submersible; T, turbine.
Drawdown: 1/ Drawdown probably less than 1 foot.
Use: H, domestic; I, irrigation; S, stock; U, unused.
Remarks: C, chemical analysis reported in table 5; L, driller's log in table 2. B, bailed; P, pumped; Air test, test pumped using compressed air for indicated time to determine yield under "Well performance." Obs, observation well whose water level is measured periodically. Sc, specific capacity. Values less than 1 are computed to the nearest 100th, values between 1 and 10 are rounded to the nearest 10th, and values greater than 10 are rounded to the nearest whole number. Where drawdown is reported as zero, actual drawdown is assumed to be less than 1 foot.

Well or spring number	Owner	Type of well	Year completed	Depth of well (ft)	Diameter of well (in)	Depth of casing (ft)	Finish	Character of material	Altitude (ft)	Water level: Feet below datum	Water level: Date	Specific conductance of water	pH	Temperature of water (°C)	Type of pump and hp	Well performance: Yield (gal/min)	Well performance: Drawdown (ft)	Use	Remarks
								T. 19 S., R. 34 E.											
18cca	K. J. Bentz	Dr	1969	402	8	207	X	Rock and sandy clay	3,900	28.30	6- 7-77	1,040	7.3	12.5	S	7	300	H	L, Sc 0.02, B 2 hr.
								T. 19 S., R. 36 E.											
30daa	Bill Robertson	Dr	1966	228	12	30	X	Clay, rock, and cinders	3,695	32	5-12-66	145	6.8	19.0	T, 60	744	126	I	C, L, Sc 5.9, P 4 hr.
31abc	do	Dr	1966	500	12	30	X	Clay and sand	3,665	9.65	6- 8-77	--	--	--	--	20	80	U	L, Sc 0.25, B 1 hr.
								T. 20 S., R. 33½ E.											
2adb	Dorman Miller	Dr	1970	150	6	20	X	Clay and gravel	3,805	5	5-21-70	308	7.2	12.0	S	10	100	H	C, L, Sc 0.10, B 1 hr.
								T. 20 S., R. 34 E.											
4bda	Ed Voltin	Dr	1974	395	6	31	X	Sandy clay	3,740	40.78	6- 7-77	--	--	--	N	3	320	U	L, Sc 0.01, B 1 hr.
4cbb(s)	Norman Clark	--	--	--	--	--	--	--	3,700	--	--	1,320	--	70.0	--	1,000	--	--	Hot spring on bank of Malheur River.
4cbd	do	Dr	1973	47	6	18	X	Clay and basalt	3,705	25	8-22-73	--	--	--	--	15	22	H	L, Sc 0.68, B 1 hr.
12dbc	J. H. Sitz	Dr	1957	120	6	13	X	Lava rock	3,575	8.54	6- 8-77	295	--	13.0	S, 0.75	20	40	H	L, Sc 0.50, B 1 hr.
								T. 20 S., R. 35 E.											
26abb	Castolia Drinkwater	Dr	1965	116	6	22	X	Clay and gravel	3,505	2.20	6- 8-77	750	7.3	12.5	J, 0.33	10	31	H	L, Sc 0.32, P 24 hr.
26abc	Fred Baker	Dr	1973	90	6	25	X	Gravel and "limestone"	3,515	6.10	do	555	--	12.5	S, 0.5	24	29	H	L, Sc 0.83, B 1 hr.
34ddd	Conley Marshall	Dr	1968	108	6	45	X	Sand and rock	3,860	37.87	6-10-77	--	--	--	S, 0.33	35	5	S	L, Sc 7.0, B 1 hr.

Table 1.--Records of selected wells and springs in the Drewsey Resource Area--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (ft)	Diameter of well (in)	Depth of casing (ft)	Finish	Character of material	Altitude (ft)	Water level: Feet below datum	Water level: Date	Specific conductance of water	pH	Temperature of water (°C)	Type of pump and hp	Well performance: Yield (gal/min)	Well performance: Drawdown (ft)	Use	Remarks
T. 20 S., R. 36 E.																			
30acc	Lee Williams	Dr	1968	105	6	22	X	Sandstone	3,525	13.15	6- 9-77	370	--	12.0	S	30	15	S	L, Sc 2.0, B 1 hr.
30daa	Terry Williams	Dr	1965	232	6	--	--	--	3,560	63.5	do	580	--	15.0	S	--	--	H	Well had been pumping prior to time of measurement.
32bba	Bill Robertson	Dr	1966	285	12	72	P, X	Broken rock	3,550	35.45	6- 8-77	480	7.2	13.5	T, 25	250	128	I	L, Sc 2.0, P 4 hr.
34ddc	U.S. Bureau of Land Management	Dr	--	101	6	--	--	--	4,030	44.91	6- 9-77	600	6.3	13.5	J, 3	--	--	S	
T. 21 S., R. 35 E.																			
3cba(s)	U.S. Bureau of Land Management	--	--	--	--	--	--	--	3,865	--	--	450	--	12.5	--	--	--	S	
13dbc	Lee Williams	Dr	1968	250	6	103	P	Gravel and sand	3,795	20.19	6-10-77	640	7.3	13.5	S, 0.75	45	22	S	C, L, Sc 2.0, B 2 hr.
T. 22 S., R. 34 E.																			
20bba	John Temple	Dr	1968	134	8	20	X	Sand and rock	4,596	12.50	6-14-77	335	6.7	14.0	P	30	30	S	C, L, Sc 1.0, B 2 hr.
T. 22 S., R. 35 E.																			
17ddc	Joe Fine	Dr	1964	115	6	115	P	Sand and gravel	3,780	6	9-21-64	460	7.4	12.5	S, 0.5	25	30	H	L, Sc 0.80, B 1 hr.
T. 22 S., R. 36 E.																			
20daa(s)	U.S. Bureau of Land Management	--	--	--	--	--	--	--	3,588	--	--	600	7.5	16.5	--	1.3	--	S	Fender Spring.
21ddc(s)	do	--	--	--	--	--	--	--	3,520	--	--	550	8.2	15.0	--	1.5	--	S	Edmunson No. 1 Spring.
T. 23 S., R. 37 E.																			
22bbc(s)	Unknown	--	--	--	--	--	--	--	3,580	--	--	450	7.9	--	--	--	--	S	Little Alkali Spring.
27dbd	Cliff Blaylock	Dr	1976	75	8	73.5	P	Broken rock	3,325	40	10-21-76	600	7.1	14.0	S, 2.0	40	2	H	C, L, Sc 20, B 4 hr. Reduction in Sc since original test.
T. 24 S., R. 37 E.																			
29dbd	Wayne Blaylock	Dr	1976	300	12	20	X	Rock	3,410	21	10- 2-76	--	--	--	N	30	100	H	L, Sc 0.30, B 3 hr.

Table 1.--Records of selected wells and springs in the Drewsey Resource Area--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (ft)	Diameter of well (in)	Depth of casing (ft)	Finish	Character of material	Altitude (ft)	Water level: Feet below datum	Water level: Date	Specific conductance of water	pH	Temperature of water (°C)	Type of pump and hp	Well performance: Yield (gal/min)	Well performance: Drawdown (ft)	Use	Remarks
T. 25 S., R. 36 E.																			
16ccb(s)	Unknown	--	--	--	--	--	--	--	3,585	--	--	650	9.1	41.0	--	--	--	U	C.
16ccc	do	Dr	--	--	12	--	--	--	3,585	--	--	470	8.6	20.0	T, 30	--	--	I	
T. 26 S., R. 31 E.																			
34ddd	H. J. Haines	Dr	1959	147	12	91	X	Lava rock and cinders	4,099	5.60	3-18-77	--	--	--	T, 40	900	11	I	Obs, L, Sc 82, P 6 hr.
T. 26 S., R. 32 E.																			
25cba	Pacific Livestock Co.	Dr	--	--	6	--	--	--	4,135	37.13	3- 8-72	400	7.5	15.0	S	--	--	S	
T. 26 S., R. 33 E.																			
11dcd	Unknown	Dr	--	158	4	--	--	--	4,107	11.06	9-19-72	--	--	--	N	--	--	U	
13daa	Lester Thompson	Dr	1968	101	12	96	P, X	Cinders	4,135	32.85	3- 2-77	--	--	--	T, 25	880	19	I	Obs, L, Sc 46, P 3 hr.
19ccc	D. B. Forslund	Dr	--	117	12	--	--	--	4,134	37.52	5-26-77	--	--	--	N	--	--	U	Discontinued observation well.
19ddc	do	Dr	--	97	12	--	--	--	4,111	14.28	6-20-77	305	7.9	12.0	N	1,150	3	U	Sc 383, P 11 hr. Discontinued observation well.
21cbb	U.S. Bureau of Land Management	Dr	--	58	--	--	--	--	4,099	3.97	5-12-72	--	--	--	N	--	--	U	T. D. Well.
26dcc	do	Dr	1955	115	6	63	X	--	4,105	11.00	6-20-77	480	8.9	13.0	P	25	10	S	C, L, Sc 2.5. Princeton Government Well.
28dcb	A. B. Hann	Dr	1957	65	16	63	P	Sand and cinders	4,107	10.55	5-13-72	--	--	--	T and C	900	32	I	L, Sc 28, P 9 hr.
33baa	D. B. Forslund	Dr	--	300	12	--	--	--	4,135	27.82	3-18-77	--	--	--	N	--	--	U	Obs.
34acc	Guy Leslie	Dr	--	96	--	--	--	Basalt and cinders	4,119	20.65	3-12-77	--	--	--	--	--	--	I	Do.
34cca	George Herrick	Dr	--	81	14	30	X	Cinders	4,120	19.99	3-18-77	--	--	--	--	--	--	I	Do.
T. 26 S., R. 34 E.																			
6acd	J. J. Fecht	Dr	--	260	--	--	--	Sand	4,125	28.92	3- 2-77	--	--	--	--	--	--	I	Obs.
19cab	F. E. Jones	Dr	1963	54	6	20	X	do	4,115	15.89	do	--	--	--	--	15	15	U	Obs, L, Sc 1.0, B 2 hr.
19dba	do	Dr	1957	130	14	66	P, X	Gravel, lava, and sand	4,120	26.26	do	--	--	--	--	1,100	--	I	Obs, L.

Table 1.--Records of selected wells and springs in the Drewsey Resource Area--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (ft)	Diameter of well (in)	Depth of casing (ft)	Finish	Character of material	Altitude (ft)	Water level: Feet below datum	Water level: Date	Specific conductance of water	pH	Temperature of water (°C)	Type of pump and hp	Well performance: Yield (gal/min)	Well performance: Drawdown (ft)	Use	Remarks
T. 27 S., R. 31 E.																			
1acb	Fred Briggs	Dr	1959	118	12	16	X	Cinders and lava rock	4,107	12.16	3- 8-72	--	--	--	T, 25	1,400	9	I	L, Sc 156, P 8 hr.
12cdc	U.S. Bureau of Land Management	Dr	1963	152	6	152	P	Lava and cinders	4,215	125	7-12-63	315	7.4	14.0	S, 1	28	1/	S	C, L, B 4 hr. Rye Grass Well.
T. 27 S., R. 32 E.																			
6baa	Fred Briggs	Dr	--	15	10	--	--	--	4,100	2.20	3- 8-72	--	--	--	--	--	--	--	
14bca	U.S. Bureau of Land Management	Dr	1963	576	6	576	P	Clay and gravel	4,515	419	4-13-63	535	8.3	18.5	S, 3	10	1/	S	C, L, B 4 hr. Voltage Well No. 1.
14ccd	do	Dr	1974	646	6	485	X	do	4,340	280	6- 4-74	440	8.2	23.5	S, 2	20	270	S	L, Sc 0.07, B 2 hr. Pumping level 500 ft. Voltage Well No. 2.
33acd	do	Dr	1963	572	6	572	P	do	4,478	382	7- 2-63	275	7.6	18.0	S, 3	10	1/	S	C, L, B 4 hr. Square Butte Well.
T. 27 S., R. 33 E.																			
2bbb	R. F. Upton	Dr	--	176	--	--	--	Lava and cinders	4,115	19.08	9-18-77	--	--	--	--	--	--	--	Obs.
20dba	U.S. Bureau of Land Management	Dr	1976	200	5	200	P	Lava rock	4,205	106.75	6-17-77	--	--	--	S, 1	3	--	S	L, Air test. Beckley Well.
23aca	do	Dr	1962	520	6 4	232 520	P	Sandstone	4,523	425	8-30-62	385	7.8	--	S, 2	8	5	S	L, Sc 1.6, B 3 hr. Hill Field Well.
T. 27 S., R. 34 E.																			
6cdc	Alfred Oltman	Dr	--	--	--	--	--	--	4,110	--	--	390	7.8	13.5	S	--	--	S	
8bcd	do	Dr	1967	215	6	20	X	Sandstone and pumice	4,141	43.83	7- 1-77	370	7.5	14.0	S, 0.33	40	1/	S	L, B 2 hr.
17cac	do	Dr	1956	230	8	60	X	Sand and gravel	4,300	190	8-22-56	295	7.8	17.5	S, 1.5	30	30	S	L, Sc 1.0.
30cdb	U.S. Bureau of Land Management	Dr	1956	291	6	254	X	Rock	4,365	261	11-22-56	310	7.8	--	S, 1	7	17	S	L, Sc 0.41.
32cdc	do	Dr	1958	164	6	92	X	"Sandrock"	4,250	--	--	330	7.5	17.0	S, 0.75	10	1	S	C, L, Sc 10. Carl Smith Well.
36aab	Unknown	Dr	--	--	6	--	--	--	4,155	54.16	6-16-77	460	6.8	15.5	P	--	--	S	

Table 1.--Records of selected wells and springs in the Drewsey Resource Area--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (ft)	Diameter of well (in)	Depth of casing (ft)	Finish	Character of material	Altitude (ft)	Water level: Feet below datum	Water level: Date	Specific conductance of water	pH	Temperature of water (°C)	Type of pump and hp	Well performance: Yield (gal/min)	Well performance: Drawdown (ft)	Use	Remarks
T. 27 S., R. 35 E.																			
17bbb	Maurice Davies	Dr	1963	275	12	176	X	Lava rock	4,149	119.50	6-30-77	600	7.4	16.0	T, 40	650	47	I	L, Sc 14, P 3 hr. Supplies two ¼-mile lines of sprinklers.
22bcd	do	Dr	1966	160	6	20	X	Sandstone	4,140	116	8-24-66	690	7.8	17.5	S	20	1/	S	L, B 1 hr.
26cad	U.S. Bureau of Land Management	Dr	1955	108	6	--	--	--	4,060	50.33	6-16-77	--	--	--	N	--	--	U	Malheur Highway Well.
28ada	do	Dr	1962	92	6	73	X	Lava rock	4,110	72.58	6-15-77	775	7.7	12.0	S	20	--	S	C, L, Air test. Anderson Valley No. 2 Well.
T. 27 S., R. 36 E.																			
33acb	Flolea Holly	Dr	1957	315	16	41	P, X	Gravel and rock	3,995	29.40	3-17-77	--	--	--	--	150	133	U	Obs, L, Sc 1.1, P 2 hr.
T. 28 S., R. 31 E.																			
1add	U.S. Bureau of Land Management	Dr	1966	278	6	142	X	Lava rock	4,226	122	1-21-66	350	--	15.5	S, 1.5	20	1/	S	C, L, P 1½ hr. Crows Nest Well.
T. 28 S., R. 32 E.																			
36ccc	Delmer McClean	Dr	1975	175	4	173	P	Rock and sand	4,180	55.6	6-18-77	--	--	--	N	35	80	U	L, Sc 0.44, Air test 1 hr.
T. 28 S., R. 33 E.																			
1bcb	U.S. Bureau of Land Management	Dr	1962	313	6	164	X	Sandstone	4,251	154	6-28-62	--	--	--	S, 5	6	1/	S	L, B 4 hr. Coon Town Well.
5dcd	do	Dr	1963	578	6	578	X	Sand and fine gravel	4,498	402.55	6-17-77	440	7.5	--	S, 5	10	1/	S	C, L, B 4 hr. Barton Lake Well.
21ccc	Jenkins Bros.	Dr	1959	60	16	4	X	Lava rock	4,192	33.39	7- 2-77	350	7.2	12.0	N	1,200	25	U	L, Sc 48, P 2 hr. Well production has dropped; no longer in use.
27ddb	Unknown	Dr	1961	289	8	41	X	Sandstone	4,345	175	11-26-61	--	--	--	--	20	1/	S	L.
T. 28 S., R. 34 E.																			
1aad	U.S. Bureau of Land Management	Dr	1962	128	6	39	X	Lava rock	4,182	78.33	6-16-77	725	7.6	14.5	S, 0.75	12	--	S	L, Air test. Anderson Valley No. 1 Well.
17bab	Otley Bros.	Dr	--	--	6	--	--	--	4,276	--	--	325	7.6	117.0	S, 1.0	--	--	S	
17bca	do	Dr	1973	840	12	234	X	Basalt	4,305	75	3-20-73	--	--	--	N	100	10	U	L, Sc 10, B 1 hr.

Table 1.--Records of selected wells and springs in the Drewsey Resource Area--Continued

Well or spring number	Owner	Type of well	Year completed	Depth of well (ft)	Diameter of well (in)	Depth of casing (ft)	Finish	Character of material	Altitude (ft)	Water level: Feet below datum	Water level: Date	Specific conductance of water	pH	Temperature of water (°C)	Type of pump and hp	Well performance: Yield (gal/min)	Well performance: Drawdown (ft)	Use	Remarks
									T. 28 S., R. 34 E.--Continued										
17cca	Otley Bros.	Dr	1960	165	6	--	--	Gravel	4,302	74.8	6-18-77	--	--	--	P	10	10	U	L, Sc 1.0.
30aaa	U.S. Bureau of Land Management	Dr	1958	338	6	207	X	Shale and gravel	4,368	137	6- 5-58	225	7.9	20.5	S	7	63	S	C, L, Sc 0.11, B ½ hr. Riddle Mountain Well.
									T. 28 S., R. 35 E.										
11dab	Tom Jenkins	Dr	--	--	6	--	--	--	4,158	--	--	200	7.2	19.0	P	--	--	S	
21dcc	do	Dr	1957	295	12	100	P, X	Sand and gravel	4,273	12.97	6-30-77	--	--	--	T, 15	550	60	U	L, Sc 9.2.
									T. 28 S., R. 36 E.										
9cab	U.S. Bureau of Land Management	Dr	1968	265	6	250	P, X	Sandstone	4,192	210	6- 4-77	275	7.4	24.5	S, 0.50	11	20	S	C, L, Sc 0.55, B 2 hr. Pollock Draw Well.
26dcc(s)	do	--	--	--	--	--	--	--	5,260	--	--	150	--	13.0	--	--	--	S	Summit Spring.
									T. 29 S., R. 32 E.										
11aca	U.S. Bureau of Land Management	Dr	1955	115	6	64	X	--	4,214	--	--	450	7.5	16.0	S	--	--	S	Barnes Well.
24cad	Hammond and McClean	Dr	1969	61	8	41	X	Sand and gravel	4,170	8	12-14-69	--	--	--	--	20	3	H	L, Sc 6.7, B 1 hr.
27bdb	Harney County	Dr	1957	430	6	--	X	--	4,270	130	12-21-57	390	7.1	20.0	S, 5	60	10	H	L (incomplete), Sc 6.0, P 2 hr.
32cba	Marvin Morger	Dr	1959	71	6	38	X	Cinders and gravel	4,180	35	9-18-59	--	--	--	J, 1	10	35	H	L, Sc 0.28, P 3 hr.
35cac	U.S. Bureau of Land Management	Dr	1962	325	6	20	X	Sandstone	4,533	272.2	6-21-77	200	--	19.0	S, 2.0	6	--	S	L, Air test.
									T. 29 S., R. 33 E.										
10bab	Walt Bailey	Dr	1964	80	6	80	P	Sand and gravel	4,172	13	9-25-64	--	--	--	S, 1.0	15	30	H	L, Sc 0.5, P 24 hr.
32abd	Mrs. Russell Aconald	Dr	1963	67	6	43	X	Cinders, sand, and gravel	4,214	8.5	9-23-63	295	6.6	12.5	--	20	16	H	L, Sc 1.25, P 48 hr.
33cdb	Rex Clemens	Dr	1971	150	8	15	X	Clay and conglomerate	4,260	25	6- 1-71	350	7.3	16.0	S	30	1/	H	L, Sc 30, B 1½ hr.

Table 1.--Records of selected wells and springs in the Drewsey Resource Area--Continued

Well or spring number	Owner	Type of well	Year com-pleted	Depth of well (ft)	Diam-eter of well (in)	Depth of cas-ing (ft)	Finish	Character of material	Alti-tude (ft)	Water level: Feet below datum	Water level: Date	Specific conduct-ance of water	pH	Temper-ature of water (°C)	Type of pump and hp	Well performance: Yield (gal/min)	Well performance: Draw-down (ft)	Use	Remarks
									T. 29 S., R. 37 E.										
17cca	Fred Pollock	Dr	--	190	--	--	--	--	4,061	93.93	3- 2-77	--	--	--	--	--	--	S	Obs.
									T. 30 S., R. 32 E.										
1dcc	U.S. Bureau of Land Management	Dr	--	--	6	--	--	--	4,495	--	--	390	7.2	18.0	S, 1	--	--	S	Pumping about 6½ gal/min after 30 min use.
8cad	do	Dr	1967	427	6	427	P, X	Sand and clay	4,445	251	1-17-67	188	7.3	20.0	S, 3	20	80	S	L, Sc 0.25, B 4 hr.
11baa	do	Dr	1962	383	6	211	X	Claystone	4,514	354.1	6-21-77	260	7.4	20.0	S, 2	10	--	S	L, Air test.
									T. 30 S., R. 33 E.										
4abc	Rex Clemens	Dr	1969	280	6	280	P	Conglomerate and shale	4,265	8	4- 8-69	250	6.5	12.0	S	18	92	I	L, Sc 0.20, P 12 hr. Owner reports water has bad taste.
4abd	do	Dr	1971	129	6	129	P	Conglomerate and clay	4,280	30	6-16-71	400	6.8	12.5	S	30	30	H	L, Sc 1.0, B 2 hr.

Table 2.--Drillers' logs of representative wells

Materials	Thickness (feet)	Depth (feet)
19S/34E-18cca. K. J. Bentz. Altitude 3,900 ft. Drilled by Holloway Drilling, 1969. Casing: 8-in diam to 207 ft; unperforated		
Soil	2	2
Clay, brown	30	32
Clay, blue	15	47
Clay, black, sandy	20	67
Clay, blue and green	114	181
Soapstone	22	203
Rock, blue	74	277
Rock, brown; some water	10	287
Rock, gray	36	323
Clay, blua	35	358
Sand, black, fine	1	359
Clay, blue	9	368
Soapstone	34	402
19S/36E-30daa. Bill Robertson. Altitude 3,695 ft. Drilled by Holloway Drilling, 1966. Casing: 12-in diam to 30 ft; unperforated		
Soil	2	2
Gravel	6	8
Clay, brown	10	18
Clay, green	84	102
Clay, blue	10	112
Clay, green	111	223
Rock, black	2	225
Cinders, red	3	228
19S/36E-31abc. Bill Robertson. Altitude 3,665 ft. Drilled by Holloway Drilling, 1966. Casing: 12-in diam to 30 ft; unperforated		
Soil, black	7	7
Clay, gray	13	20
Sand, dry	6	26
Clay, gray	174	200
Clay, blue	114	314
Sand	1	315
Clay, brown	110	425
Clay, black	45	470
Clay, gray	30	500
Clay, blue	2	502
Soapstone, caving	3	505
20S/33½E-2adb. Dorman Miller. Altitude 3,305 ft. Drilled by Skinner & Sons Drilling, 1970. Casing: 6-in diam to 20 ft; unperforated		
Clay, brown	5	5
Gravel and clay, brown	7	12
Clay, blue, and some gravel, watar-bearing	138	150
20S/34E-4bda. Ed Voltin. Altitude 3,740 ft. Drilled by Page Bros. Drilling, 1974. Casing: 6-in diam to 31 ft; unperforated		
Clay, yellow, fine	6	6
Gravel, cemented	12	18
Clay, yellow	16	34
Clay, brown	36	70
Basalt, dark-gray, hard	20	90
Clay, dark-brown	15	105
Clay, yellow	17	122
Clay, gray	11	133
Clay, dark-brown	13	146
Clay, gray	29	175
Clay, dark-brown	17	192
Clay, blue, sticky	193	385
Clay, blue, sandy	10	395
20S/34E-4cbd. Norman Clark. Altitude 3,705 ft. Drilled by Page Bros. Drilling, 1973. Casing: 6-in diam to 18 ft; unperforated		
Clay, with boulders	16	16
Clay, brown, water-bearing	21	37
Basalt	10	47
20S/34E-12dbc. J. H. Sitz. Altitude 3,575 ft. Drilled by Sevey Drilling, 1957. Casing: 6-in diam to 13 ft; unperforated		
Boulders and gravel	15	15
Rock, green, soft	25	40
Basalt, with crevices	80	120
20S/35E-26abb. Castolia Drinkwater. Altitude 3,505 ft. Drilled by Skinner & Sons Drilling, 1965. Casing: 6-in diam to 22 ft; unperforated		
Soil, brown	2	2
Gravel	11	13
Rock, black	2	15
Sand and gravel	3	18
Clay, blue; some water	12	30
Rock, blue	12	42
Clay, blue	52	94
Clay, blue, with gravel, water-bearing	4	98
Clay, blue	16	114
Clay, brown, with gravel, watar-bearing	2	116
20S/35E-26abc. Fred Baker. Altitude 3,515 ft. Drilled by Page Bros. Drilling, 1973. Casing: 6-in diam to 25 ft; unperforated		
Soil	12	12
Gravel, fine, water-bearing	11	23
"Serpentine"	17	40
Sandstona	3	43
Clay, brown	37	80
"Limestone," water-bearing	10	90
20S/35E-34ddd. Conley Marshall. Altitude 3,860 ft. Drilled by Holloway Drilling, 1968. Casing: 6-in diam to 45 ft; unperforated		
Soil	4	4
Clay, with gravel	6	10
Clay, yellow	15	25
Clay, red	30	55
Rock, sandy	45	100
Rock, gray, porous	8	108

20S/36E-30acc. Lee Williams. Altitude 3,525 ft. Drilled by Holloway Drilling, 1968. Casing: 6-in diam to 22 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Clay, brown	13	18
Sandstone	7	25
Sand, coarse	1	26
Sandstone	20	46
Clay	28	74
Rock, gray	31	105

20S/36E-32bba. Bill Robertson. Altitude 3,550 ft. Drilled by Holloway Drilling, 1966. Casing: 12-in diam to 72 ft; perforated 22-72 ft

Materials	Thickness (feet)	Depth (feet)
Soil	7	7
Clay	8	15
Rock, gray	40	55
Rock, broken	16	71
Rock, black, hard	11	82
Rock, red	30	112
Rock, black	36	148
Clay, black	72	220
Clay, brown	65	285

21S/35E-13dbc. Lee Williams. Altitude 3,795 ft. Drilled by Holloway Drilling, 1968. Casing: 6-in diam to 103 ft; perforated 22-100 ft

Materials	Thickness (feet)	Depth (feet)
Soil, sandy	7	7
Clay, brown	23	30
Clay, blue	15	45
Gravel, small-sized	1	46
Clay, black	174	220
Clay, green	11	231
Sand, green	1	232
Clay, green	18	250

22S/34E-20bba. John Temple. Altitude 4,596 ft. Drilled by Holloway Drilling, 1968. Casing: 8-in diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Clay	22	24
Sand	1	25
Clay, blue	104	129
Rock, creviced	5	134

22S/35E-17ddc. Joe Fine. Altitude 3,780 ft. Drilled by Skinner & Sons Drilling, 1964. Casing: 6-in diam to 115 ft; perforated 110-115 ft

Materials	Thickness (feet)	Depth (feet)
Soil	6	6
Sand, fine	6	12
Clay, sandy	8	20
Gravel, medium	12	32
Clay, blue	68	100
Sand, black, and small gravel	10	110
Rock, red	5	115

23S/37E-27dbd. Cliff Blaylock. Altitude 3,325 ft. Drilled by Harold E. Hartling Drilling, 1976. Casing: 8-in diam to 73½ ft; perforated 68-70 ft

Materials	Thickness (feet)	Depth (feet)
Clay and rock	19	19
Rock, black	9	28
Rock, broken	4	32
Rock, black, solid	31	63
Rock, black, broken	3	66
Rock, black, solid	4	70
Rock, black, porous	3	73
Clay, brown	2	75

24S/37E-29dbd. Wayne Blaylock. Altitude 3,410 ft. Drilled by Harold E. Hartley Drilling, 1976. Casing: 12-in diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Clay and rock	10	10
Rock, black	35	45
Pumice, gray	7	52
Clay, brown	28	80
Clay, blue	98	178
Clay, green, sticky	57	235
Clay, black	17	252
Clay, green, sticky	48	300

26S/31E-34ddd. M. J. Haines. Altitude 4,099 ft. Drilled by Rossberg & Son Irrigation, 1959. Casing: 12-in diam to 91 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil and hardpan	40	40
Clay, blue	20	60
Sandstone	13	73
Gravel, small	1	74
Clay, blue	6	80
Gravel, small	4	84
Quicksand	3	87
Basalt	28	115
Cinders, red, hard	25	140
Cinders, red, loose	7	147

26S/33E-13daa. Lester Thompson. Altitude 4,135 ft. Drilled by Jack McClure Drilling, 1957. Casing: 14-in diam to 40 ft; unperforated. Reconditioned 1968; 12-in liner; perforated to 96 ft

Materials	Thickness (feet)	Depth (feet)
Soil	11	11
Clay, yellow	23	34
Rock, lava	30	64
Cinders, coarse, water-bearing	3	67
Clay, red	7	74
Rock, yellow	4	78
Clay, yellow	5	83
Rock	22	105
Cinders, water-bearing	3	108

26S/33E-26dcc. U.S. Bureau of Land Management. Altitude 4,105 ft. Drilled in 1955; driller unknown. Casing: 6-in diam to 63 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Clay	64	64
Rock	31	95
Rock, soft	2	97
Sand	1	98
Clay	11	109
Clay, with sand streaks	5	114
Silt	1	115

26S/33E-28dcb. A. B. Hann. Altitude 4,107 ft. Drilled by W. C. Smoot Drilling, 1957. Casing: 16-in diam to 63 ft; perforated 13-38 ft

Materials	Thickness (feet)	Depth (feet)
Soil, sandy loam	16	16
Quicksand and clay, water-bearing	4	20
Clay and sand	8	28
Sand and silt, blue	7	35
Clay, soft, and sand	10	45
Cinders, black, water-bearing	10	55
Cinders, red, water-bearing	10	65

26S/34E-19cab. F. E. Jones. Altitude 4,115 ft. Drilled by Skinner & Sons Drilling, 1963. Casing: 6-in diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, brown	3	3
Clay, yellow	27	30
Clay, blue, with trace of black sand	24	54

26S/34E-19dba. F. E. Jones. Altitude 4,120 ft. Drilled by Jack McClure Drilling, 1957. Casing: 14-in diam to 66 ft; perforated 25-35 ft and 55-65 ft

Materials	Thickness (feet)	Depth (feet)
Soil	16	16
Clay, yellow	15	31
Gravel, water-bearing	2	33
Clay, yellow	31	64
Gravel	2	66
Rock, lava	22	88
Clay, yellow	34	122
Sand	8	130

27S/31E-1acb. Fred Briggs. Altitude 4,107 ft. Drilled by Rossberg & Son Irrigation, 1959. Casing: 12-in diam to 16 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
"Hardpan"	7	12
Basalt, gray	59	71
Cinders, red	28	99
Rock, lava, black	4	103
Cinders, black	7	110
Bentonite, yellow	8	118

27S/31E-12cdc. U.S. Bureau of Land Management. Altitude 4,215 ft. Drilled by Skinner & Sons Drilling, 1963. Casing: 6-in diam to 152 ft; perforated 112-151 ft

Materials	Thickness (feet)	Depth (feet)
Boulders, loose	16	16
Rock, black, solid	2	18
Boulders, loose	33	51
Rock, black, hard, and red rock	48	99
Rock, gray, hard	18	117
Rock, black, hard	13	130
Cinders, red and black, loose	20	150
Lava, red, water-bearing	1½	151½

27S/32E-14bca. U.S. Bureau of Land Management. Altitude 4,515 ft. Drilled by Skinner & Sons Drilling, 1963. Casing: 6-in diam to 576 ft; perforated 546-576 ft

Materials	Thickness (feet)	Depth (feet)
Soil, brown	1	1
Rock, black	7	8
Boulders, loose	2	10
Cinders, loose	9	19
Boulders, loose	5	24
Rock, black and gray, solid	40	64
Cinders, black and red	12	76
Boulders, loose	29	105
Rock, brown, with crevices	22	127
Rock, red, soft	48	175
Rock, black	25	200
Sandstone, white	30	230
Sand, white	30	260
Sandstone, white	40	300
Clay with gravel, brown	175	475
Clay, blue	25	500
Clay, blue, some water	50	550
Clay, blue, with gravel, water-bearing	26	576

27S/32E-14ccd. U.S. Bureau of Land Management. Altitude 4,340 ft. Drilled by Skinner & Sons, 1974. Casing: 6-in diam to 485 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, black	10	10
Rock, black, hard	10	20
Rock, soft	10	30
Rock, gray, hard, with crevices	35	65
Cinders, black and red	17	82
Rock, black, hard	53	135
Rock, black, hard, with red streaks	45	180
Rock, black, red, and brown, with cinders	20	200
Rock, gray, soft	15	215
Rock, multicolored	15	230
Rock, black and brown, soft	20	250
Rock, black and red, hard	70	320
Sand, white	150	470
Clay, blue, and claystone, sandy	10	480
Clay, greenish-blue	70	550
Claystone, sandy, layered	10	560
Clay, green and blue, with gravel; some water-	86	646

27S/32E-33acd. U.S. Bureau of Land Management. Altitude 4,478 ft. Drilled by Skinner & Sons, 1963. Casing: 6-in diam to 572 ft; perforated 532-572 ft

Materials	Thickness (feet)	Depth (feet)
Boulders, large	10	10
Rock, black, hard, broken	20	30
Rock, lava, black, hard	36	66
Rock, black, hard, broken	17	83
Rock, black, hard, solid	22	105
Rock, broken	10	115
Rock, lava, red, gray, and black, hard	97	212
Rock, gray, hard	48	260
Rock, lava, red and black	37	297
Rock, lava, black, with brown clay	20	317
Clay, yellow	27	344
Rock, red, soft	6	350
Sandstone, brown	30	380
Claystone, brown	44	424
Clay, yellow	19	443
Clay, green and yellow	18	461
Claystone, yellow	14	475
Clay, blue	48	523
Clay, yellow	37	560
Clay, yellow, with coarse gravel, water-bearing	12	572

27S/33E-20dba. U.S. Bureau of Land Management. Altitude 4,205 ft. Drilled by Northwest Drilling, 1976. Casing: 5-in diam to 200 ft; perforated 120-200 ft

Materials	Thickness (feet)	Depth (feet)
Soil	6	6
Claystone, brown	9	15
Claystone, gray, hard	5	20
Claystone, brown	60	80
Rock, lava, gray	120	200

27S/33E-23aca. U.S. Bureau of Land Management. Altitude 4,523 ft. Drilled by Skinner & Sons, 1962. Casing: 6-in diam to 232 ft, 4-in diam to 520 ft; perforated 490-515 ft

Materials	Thickness (feet)	Depth (feet)
Soil, with loose rock	1½	1½
Lava, broken	38½	40
Cinders, red	2	42
Lava, gray, hard, creviced	18	60
Lava, red, broken	90	150
Lava, gray, hard	10	160
Lava, red, broken	15	175
Cinders, red	10	185
Lava, red, broken	40	225
Rock, gray and black, hard	45	270
Lava, red, broken	15	285
Cinders, red	5	290
Lava, black, hard	10	300
Rock, gray, hard	30	330
Cinders, red	5	335
Clay, brown, sandy	22	357
Clay, yellow	145	502
Sandstone, white, water-bearing	13	515
Sand, black, medium	5	520
Rock, hard	½	520½

27S/34E-8bcd. Alfred Oltman. Altitude 4,141 ft. Drilled by Skinner & Sons, 1967. Casing: 6-in diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, brown	3	3
Rock, lava, black, hard	27	30
Clay, brown	150	180
Sandstone, brown	30	210
Sandstone, black, with white pumice; water-bearing	5	215

27S/34E-17cac. Alfred Oltman. Altitude 4,300 ft. Drilled by Jack McClure Drilling, 1956. Casing: 8-in diam to 60 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Rock	12	14
Clay	38	52
Gravel	2	54
Pumice	86	140
Shale, red	85	225
Sand and gravel, water-bearing	5	230

27S/34E-30cdb. U.S. Bureau of Land Management. Altitude 4,365 ft. Drilled to 291 ft in 1956; driller unknown. Casing: 6-in diam to 254 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, with clay, sand, and gravel	7	7
Rock, gray, hard and soft, with crevices	52	59
Rock, pink, solid, with crevices	4	63
Rock, gray	8	71
Rock, with crevices	22	93
Rock, solid	6	99
Clay	3	102
Rock, solid	3	105
Crevice	1	106
Rock, solid	3	109
Sand, with cinders	2	111
Rock, with alternate solid and crumbly layers	22	133
Cinders, red	9	142
Ash, volcanic	75	217
Rock, "porcelain-like"	1	218
Ash, volcanic	11	229
Tuff	23	252
Rock, brown	20	272
Rock, black and brown, water-bearing	18½	290½
Rock, pink, firm	½	291

27S/34E-32cdc. U.S. Bureau of Land Management. Altitude 4,250 ft. Drilled in 1958; driller unknown. Casing: 6-in diam to 92 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, with clay, sand, and broken rock	10	10
Rock, broken	8	18
Rock, gray, solid	13	31
Rock, red, pink, and gray	48	79
Sand and gravel, dry	4	83
Rock, crumbly, and some sand	7	90
Rock, firm, with some soft rock and tuff	7	97
Tuff	11	108
Rock, hard and soft, with crevice	26	134
Cinders, red	2	136
Tuff	13	149
Sand, with tuff and cinders	4	153
Sandstone, water-bearing	5	158
Rock, hard	5½	163½

27S/35E-17bbb. Maurice Davies. Altitude 4,149 ft. Drilled by Skinner & Sons, 1963. Casing: 12-in diam to 176 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Sand, light-brown, coarse	2	4
Clay, brown, sandy	57	61
Sandstone, brown, water-bearing	9	70
Gravel, medium-brown, with clay	27	97
Sand, gray, fine, and brown clay, water-bearing	30	127
Gravel, medium, with brown clay	37	164
Clay, yellow	10	174
Clay, blue	29	203
Rock, lava, red and black, soft	11	214
Sandstone, black, with trace of gravel, water-bearing	5	219
Rock, lava, black, soft and hard, water-bearing	34	253
Rock, lava, black, with yellow, brown, and red clay, water-bearing	13	266
Clay, yellow	4	270
Rock, lava, red, yellow, and black, with blue clay	5	275

27S/35E-22bcd. Maurice Davies. Altitude 4,140 ft. Drilled by Skinner & Sons, 1966. Casing: 6-in diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, brown, sandy	1	1
Clay, brown, soft, with some fine gravel	129	130
Rock, multicolored, soft	3	133
Sandstone, water-bearing	27	160

27S/35E-28ada. U.S. Bureau of Land Management. Altitude 4,110 ft. Drilled by W. E. Majors, 1962. Casing: 6-in diam to 73 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	10	10
Clay, gray	10	20
Rock, lava	40	60
Cinders, red	10	70
Rock, lava, water-bearing	22	92

27S/36E-33acb. FloLea Holly. Altitude 3,995 ft. Drilled by Holloway Drilling Co., 1957. Casing: 16-in diam to 41 ft; perforated 17-38 ft

Materials	Thickness (feet)	Depth (feet)
Soil	10	10
Clay and gravel	23	33
Gravel, water-bearing	5	38
Clay, yellow	17	55
Shale, blue	43	98
Rock, black, hard	17	115
Crevice, with broken rock	5	120
Rock, black, hard	34	154
Rock, brown, coarse	11	165
Clay, bentonite	11	176
Rock, black, hard	9	185
Rock, red	10	195
Rock, black, hard	30	225
Rock, broken	5	230
Rock, brown, hard	10	240
Clay, red, cinders	22	262
Rock, black, hard	46	308
Rock, broken	7	315

28S/31E-1add. U.S. Bureau of Land Management. Altitude 4,226 ft. Drilled by Dick Akins Well Drilling, 1966. Casing: 6-in diam to 142 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil, sandy	2	2
Lava, gray, hard	56	58
Cinders, red	11	69
Lava, gray, hard	9	78
Cinders, black	38	116
Lava, gray, shattered	11	127
Lava, gray, hard	51	178
Lava, gray, medium	53	231
Lava, soft	40	271
Lava, hard	7	278

28S/32E-36ccc. Delmer McClean. Altitude 4,180 ft. Drilled by Larry Burd Well Drilling, 1975. Casing: 6-in diam to 35 ft; 4-in diam 0-173 ft; perforated 113-173 ft

Materials	Thickness (feet)	Depth (feet)
Sand	30	30
Basalt, gray	55	85
Clay, brown	1	86
Basalt, gray	19	105
Sand	3	108
Claystone	42	150
Rock and sand	25	175

Materials	Thickness (feet)	Depth (feet)
28S/33E-1bcb. U.S. Bureau of Land Management. Altitude 4,251 ft. Drilled by Skinner & Sons, 1962. Casing: 6-in diam to 164 ft; unperforated		
Soil, brown	2	2
Boulders	73	75
Sandstone	6	81
Rock, black	22	103
Rock, red	10	113
Rock, black	7	120
Rock, red, with black streaks	13	133
Rock, black	12	145
Rock, brown	6	151
Rock, black	3	154
Sand, black, fine	4	158
Rock, black	8	166
Rock, black and brown	9	175
Rock, black, with red streaks	9	184
Claystone, brown, with sand; some water	111	295
Sandstone, brown, water-bearing	17½	312½
28S/33E-5dcd. U.S. Bureau of Land Management. Altitude 4,498 ft. Drilled by Skinner & Sons, 1963. Casing: 8-in diam 0-40 ft, 6-in diam 0-578 ft; unperforated		
Rock, gray, hard	10	10
Rock, black, broken	25	35
Rock, black	27	62
Boulders, large	3	65
Rock, black, hard	22	87
Cinders, red	3	90
Rock, black, hard	72	162
Rock, gray, hard	17	179
Cinders, red, hard	5	184
Clay, brown	5	189
Clay, brown, with coarse gravel	34	223
Sand, white, fine	3	226
Clay, white	82	308
Clay, brown, sandy	98	406
Clay, yellow	79	485
Rock, lava, black	6	491
Clay, yellow	24	515
Clay, yellow, with coarse sand and fine gravel; water-bearing	38	553
Clay, green, with fine gravel; water-bearing	14	567
Sand, coarse, with trace of green clay; water-bearing	11	578
28S/33E-21ccc. Jenkins Bros. Altitude 4,192 ft. Drilled by Rich Knoblock Drilling, 1959. Casing: 16-in diam to 4 ft; unperforated		
Soil	2½	2½
Lava, hard	22½	25
Lava, broken (softer)	12	37
Lava, dark-gray	12	49
Basalt, hard, and soft gray lava	9	58
Cinders	2	60
28S/33E-27ddb. Unknown. Altitude 4,345 ft. Drilled by Skinner & Sons, 1961. Casing: 8-in diam to 40½ ft; unperforated		
Soil, brown	2	2
Clay, red, with fine gravel	18	20
Clay, brown, with fine gravel	60	80
Clay, gray, with fine gravel	6	86
Clay, brown, with fine gravel	48	134
Clay, red	66	200
Rock, gray; some water	1	201
Clay, tan, with fine gravel	71	272
Sandstone, gray, water-bearing	17	289
28S/34E-1aad. U.S. Bureau of Land Management. Altitude 4,182 ft. Drilled by W. E. Majors, 1962. Casing: 6-in diam to 39 ft; unperforated		
Boulders	31	31
Cinders, gray	6	37
Rock, lava; water at 118 ft	91	128
28S/34E-17bca. Otley Bros. Altitude 4,305 ft. Drilled by John W. Rossberg, 1973. Casing: 12-in diam to 234 ft; unperforated		
Soil, brown	2	2
Gravel, medium and coarse	6	8
Clay, yellow	87	95
Clay, brown	45	140
Clay, blue	40	180
Rock, gray, hard	2	182
Pumice and clay, mixed	63	245
Basalt, red, hard	20	265
Clay, red and green	40	305
Basalt, gray	5	310
Clay, blue	80	390
Chalk, white	5	395
Clay, blue	150	545
Clay, red	10	555
Basalt, red	5	560
Basalt, black	110	670
Basalt, red	20	690
Clay, blue	15	705
Basalt, red	5	710
Basalt, gray, very hard	130	840
28S/34E-17cca. Otley Bros. Altitude 4,302 ft. Drilled by Crane Drilling, 1960. Casing: 6-in diam to unknown depth		
Soil	3	3
Gravel	12	15
Clay, reddish	30	45
Clay, yellow	45	90
Shale, blue	6	96
Clay, gray, crumbly	2	98
Shale, blue	32	130
Clay, yellow	15	145
Clay, blue	15	160
Gravel, water-bearing	5	165
28S/34E-30aaa. U.S. Bureau of Land Management. Altitude 4,368 ft. Drilled by Rich Knoblock Drilling, 1958. Casing: 6-in diam to 338 ft; unperforated		
Soil	2	2
Lava boulders	10	12
Clay, light volcanic ash, with lava boulders	38	50
Lava boulders, large	18	68
"Volcanics," light-brown, with lava gravel	78	146
Soapstone and clay, gray and brown	34	180
Shale, blue-green	32	212
Shale, blue, with some imbedded gravel	36	248
Conglomerate	5	253
Clay and shale, light-green	43	296
Rock, hard	3	299
Rock, dark-brown, soft and crumbled	2	301
Clay, blue-green, and shale, with streaks of soapstone and gravel	37	338
28S/35E-21dcc. Tom Jenkins. Altitude 4,273 ft. Drilled by Rich Knoblock Drilling, 1957. Casing: 12-in diam to 100 ft; perforated 55-85 ft		
Silt, black	14	14
Gravel	1	15
Silt	11	26
Clay and some gravel	33	59
Sand, loose	19	78
Gravel and clay, layered	6	84
Rock, "soapstone-like"	173	257
Gravel, layered	13	270
Sandstone, with clay	8	278
Soapstone, dense, with some gravel	17	295

28S/36E-9cab. U.S. Bureau of Land Management. Altitude 4,192 ft. Drilled by Rich Knoblock Drilling, 1959. Deepened to 325 ft in 1963; later caved. Redrilled to 265 ft in 1968 by John W. Rossberg. Casing: 6-in diam to 250 ft; perforated 210-220 ft

Materials	Thickness (feet)	Depth (feet)
Soil, "adobe"	1½	1½
Boulders, dense	14½	16
Clay, brown, heavy	26	42
Pumice	24	66
Clay, brown, medium	23	89
Soil, brown, sandy	27	116
Rock, gray	6	122
Clay, brown, medium, and some ash	44	166
Soapstone, soft	5	171
Clay, brown, gravelly	31	202
Cinders, with medium clay	14	216
Clay, blue, medium, gravelly	14	230
Clay, yellow, gravelly	10	240
"Rhyolite"	3	243
Clay, yellow	42	285
Clay, yellow, with sand	35	320
Gravel, water-bearing	5	325

29S/32E-24cad. Hammond and McClean. Altitude 4,170 ft. Drilled by Jack McClure, 1969. Casing: 8-in diam to 41 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	4	4
Clay, yellow	5	9
Sand, water-bearing	28	37
Clay, yellow	21	58
Gravel, small, water-bearing	3	61

29S/32E-27bdb. Harney County. Altitude 4,270 ft. Drilled by Rich Knoblock Drilling, 1957. Casing: 6-in diam to unknown depth

Materials	Thickness (feet)	Depth (feet)
Unknown	180	180
Soapstone, brownish-gray	215	395
Shale, blue	35	430

29S/32E-32cba. Marvin Morger. Altitude 4,180 ft. Drilled by Rossberg & Son Irrigation, 1959. Casing: 6-in diam to 38 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	20	20
Gravel, pea-sized	30	50
Cinders, red, and gravel	10	60
Gravel, reddish	10	70
Basalt, hard	1	71

29S/32E-35cac. U.S. Bureau of Land Management. Altitude 4,533 ft. Drilled by Majors Drilling Sales & Service, 1962. Casing: 6-in diam to 20 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	3	3
Boulders	30	33
Sandstone, red	2	35
Sandstone, brown	105	140
Sandstone, white	2	142
Sandstone, brown	93	235
Sandstone, white	10	245
Sandstone, brown, water-bearing	80	325

29S/33E-30bab. Walt Bailey. Altitude 4,172 ft. Drilled by Jack McClure Drilling, 1964. Casing: 6-in diam to 80 ft; perforated 70-80 ft

Materials	Thickness (feet)	Depth (feet)
Soil	13	13
Sand and clay	9	22
Sand	44	66
Clay, yellow	8	74
Sand and gravel	6	80

29S/33E-32abd. Mrs. Russell Aronald. Altitude 4,214 ft. Drilled by Rossberg & Son Irrigation, 1963. Casing: 6-in diam to 43 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	6	6
Gravel, cemented	13	19
Sand and gravel, brown	24	43
Rock, cinders, red	15	58
Sand, cemented	8	66
Gravel, fine	1	67

29S/33E-33cdb. Rex Clemens. Altitude 4,260 ft. Drilled by Woerner Drilling & Pump Service, 1971. Casing: 8-in diam to 35 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Conglomerate, medium-sized	28	28
Claystone, brown	25	53
Claystone, red	9	62
Claystone, brown	45	107
Claystone, gray	9	116
Claystone, brown	5	121
Clay and conglomerate	6	127
Claystone, brown	23	150

30S/32E-8cad. U.S. Bureau of Land Management. Altitude 4,445 ft. Drilled by Dick Akins Well Drilling, 1967. Casing: 6-in diam to 427 ft; perforated 327-347 ft and 407-426 ft

Materials	Thickness (feet)	Depth (feet)
Soil, sandy	2	2
Clay, yellow, and broken rock	36	38
Sandstone, brown, soft	57	95
Rock, pink, soft	7	102
Rock, lava, gray, medium	24	126
Claystone, green	13	139
Rock, lava, gray, medium	24	163
Sand, with small amount of brown clay binder	264	427

30S/32E-11baa. U.S. Bureau of Land Management. Altitude 4,514 ft. Drilled by W. E. Majors Drilling, 1962. Casing: 6-in diam to 211 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Soil	2	2
Sandstone, gray	43	45
Sandstone, brown	70	115
Cinders	19	134
Boulders	44	178
Cinders	24	202
Clay, brown	28	230
Claystone, gray	10	240
Claystone, brown; water at 376 ft	143	383

30S/33E-4aba. Rex Clemens. Altitude 4,280 ft. Drilled by Woerner Drilling & Pump Service, 1971. Casing: 8-in diam to 30 ft, 6-in diam to 129 ft; unperforated

Materials	Thickness (feet)	Depth (feet)
Conglomerate	15	15
Lava	14	29
Clay, red	20	49
Lava	6	55
Clay, brown	35	90
Claystone, brown	7	97
Clay and conglomerate, brown	27	124
Clay and conglomerate, red	5	129

30S/33E-4abc. Rex Clemens. Altitude 4,265 ft. Drilled by Woerner Drilling & Pump Service, 1969. Casing: 8-in diam to 125 ft, 6-in diam to 280 ft; perforated 260-280 ft

Materials	Thickness (feet)	Depth (feet)
Soil	5	5
Conglomerate	15	20
Clay, brown, and conglomerate	160	180
Clay, greenish-yellow	24	204
Clay, red	36	240
Clay, brown, and conglomerate	12	252
Conglomerate and yellow shale	28	280

Table 3.--Summary of observation-well data

Well number	Depth (feet)	Aquifer	Period of record		Depth to water, in feet below land surface				Water-level trend[1]	Annual rate of change (feet)
			Begin	End	Highest	Date	Lowest	Date		
22S/30E-27ddc	127	Tvs	1966	--	42.80	9-24-76	59.64	8-27-73	Falling	-0.3
22S/31E-28ddb	490	Qal, Tvs	1966	--	13.30	11-18-76	31.46	6-21-73	Stable	--
34ccb	288	do	1930	--	1.50	4-21-36	19.82	6- 6-74	Falling	-.5
36bab	335	do	1963	1976	4.87	5-21-64	17.54	8-22-68	do	-.5
22S/32½E-30cdb	647	do	1966	1976	4.00	5-18-67	15.25	8-29-73	Stable	--
22S/33E-27adc	833	Tvs	1966	--	12.02	do	52.15	8-22-68	Falling	-1.2
23S/30E-36bbc	198	do	1969	--	[2]1.86	3- 3-77	5.89	8-21-75	Stable	--
23S/31E-3bbb	14	Qal	1936	1970	1.69	2-25-63	10.41	12-12-44	do	--
5aac	400	Tvs	1962	--	10.92	4-18-62	24.61	11-30-67	Falling	-.3
11dcc1	120	Qal	1959	--	3.70	5-18-75	11.5	1- 6-74	Stable	--
11dcc2	561	Tvs	1959	--	6.90	5- 3-71	29.1	7- 8-73	do	--
14aab	17	Qal	1936	1970	1.50	4-16-52	13.20	1-15-36	do	--
16bcc	14	do	1936	1971	.80	do	9.10	do	do	--
16dbb	300	Tvs	1930	--	3.95	5-20-65	16.75	8-23-72	do	--
33cbc	13	Qal	1936	1970	.28	5-22-65	8.57	12-11-68	do	--
23S/32E-3aad	220	--	1965	--	6.04	3-25-71	24.08	8-21-75	Uncertain	--
7cab	93	Qal	1928	--	2.07	5-19-65	38.37	7-30-31	Stable	--
28aba	140	do	1966	1971	15.26	5-21-70	42.74	5-23-68	--	--
29adb	240	do	1967	--	15.12	5-27-71	34.30	8-22-68	Falling	-.3
30ddd	19	do	1936	1970	5.43	5-21-70	Dry	1-15-58	Stable	--
23S/32½E-1bbb	300	do	1965	--	2.58	2-25-76	15.33	8-29-74	Stable	--
23S/33E-36ad	85	do	1966	1970	5.53	5-18-67	10.84	12-12-68	--	--
23S/34E-31add	207	Tvs	1971	--	16.80	5-22-75	22.74	8-21-75	Stable	--
24S/30E-7cdd	347	do	1962	--	16.23	5-19-67	21.22	9- 2-76	Falling	-.2
26dda	501	do	1962	1972	25.77	4-19-62	50.68	10-11-68	Stable	--
24S/31E-28bcc	17	Qal	1936	1970	2.76	4-16-52	13.06	9- 8-36	do	--
24S/32½E-30ddc	130	--	1963	--	21.79	5-27-76	27.44	8-21-63	Rising	+.4
24S/34E-31bac	95	Tb	1959	--	23.90	5-20-65	34.95	8-29-74	Falling	-.3
31cbd	110	Qal	1963	--	19.71	do	27.80	11-17-76	do	-.3
31dcb	301	--	1962	1967	30.12	8-23-62	36.06	11-30-67	--	--
25S/31E-4cba	170	Qal	1962	1970	34.70	3- 3-70	37.67	9-11-68	--	--
29ccb	209	do	1963	1970	70.54	6-10-70	71.57	10-13-68	--	--

See footnotes at end of table.

Table 3.--Summary of observation-well data--Continued

Well number	Depth (feet)	Aquifer	Period of record		Depth to water, in feet below land surface				Water-level trend[1/]	Annual rate of change (feet)
			Begin	End	Highest	Date	Lowest	Date		
25S/34E-30dcc	41	Tb	1962	--	31.60	3- 9-66	35.29	6- 5-74	Stable	--
26S/31E-26bba	230	Qal	1965	1967	12.74	2-15-66	13.28	3- 4-65	--	--
34ddd	147	Tb	1964	--	4.50	12-15-76	7.42	11-20-68	Stable	--
26S/33E-13daa	108	do	1962	--	31.55	9-20-72	33.50	8-19-70	do	--
19ccc	117	do	1959	1976	37.36	2-16-73	40.30	6-18-69	do	--
19ddc	97	do	1962	1976	14.42	3- 1-76	16.28	8-23-62	do	--
28cdb	65	do	1962	1970	10.70	12- 2-65	12.51	do	do	--
33baa	300	do	1958	--	27.82	3-18-77	29.60	do	do	--
34acc	96	do	1956	--	20.65	3-12-77	22.50	6-18-69	do	--
34cca	81	do	1962	--	19.66	12- 2-65	23.60	12-15-76	do	--
26S/34E-6acd	260	Qal	1962	--	28.39	do	30.57	8-21-68	do	--
6dab	297	do	1960	1967	31.26	3- 9-66	31.82	5-22-64	do	--
19cab	54	do	1974	--	15.89	3- 2-77	17.03	9- 1-76	--	--
19dba	130	Qal	1962	--	25.85	3- 9-66	27.00	8-28-74	Stable	--
27S/31E-1acb	118	Tb	1962	1968	11.98	8-26-65	14.09	4-19-62	--	--
27S/33E-2bbb	176	do	1956	--	19.08	3-18-77	25.97	8-23-62	Stable	--
27S/36E-33acb	312	do	1963	--	25.22	5-25-72	31.40	3- 9-69	do	--
29S/37E-17cca	190	--	1965	--	92.44	5-19-65	106.18	2-25-75	do	--

1/ Refers to latest 10 years of record; where period of record is less than 10 years, no comment is made.

2/ Well reportedly flowed at land surface when drilled (Leonard, 1970, p. 36).

Table 4.--Source and significance of chemical and physical characteristics of water

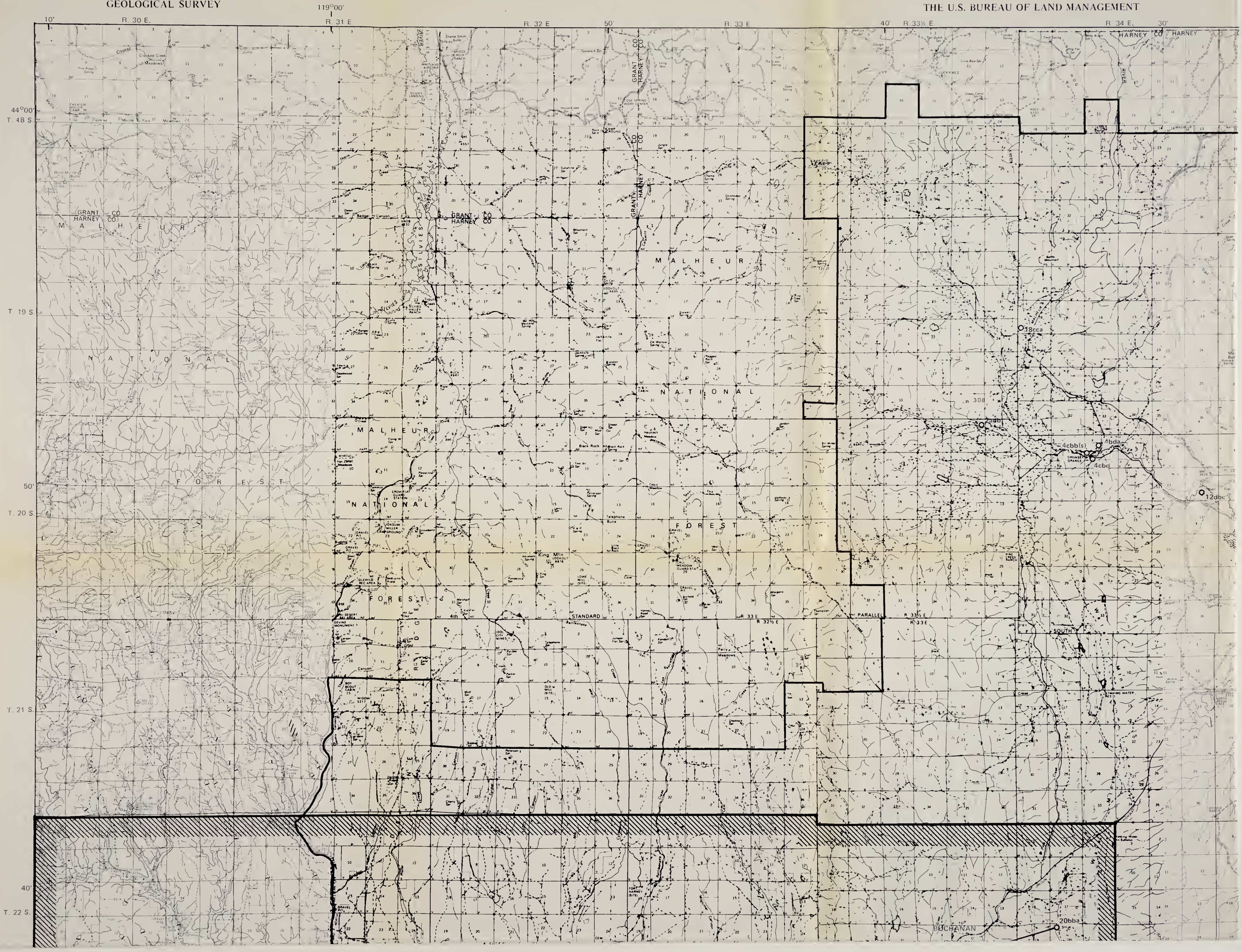
Constituent	Potential source(s)	Significance or definition
Silica (SiO_2)	Silicate minerals in rocks.	Forms hard scale in high-pressure boilers.
Iron (Fe)	Iron-bearing minerals, well casings, and pipes.	In concentrations greater than 0.3 mg/L, may stain laundry and porcelain plumbing fixtures (National Academy of Sciences, 1974). Larger concentrations may impart objectionable taste to water.
Manganese (Mn)	Manganese-bearing minerals, decomposition of plant tissue.	In concentrations greater than 0.05 mg/L may cause brown to black stain in laundry and porcelain plumbing fixtures (National Academy of Sciences, 1974). Generally has same objectionable features as iron.
Calcium (Ca)	Rocks, soils, and "hardpan" deposits rich in calcium carbonate minerals and from fertilizers.	A constituent of scale deposits in water pipes, boilers, and cookware. Principal cause of water hardness.
Magnesium (Mg)	Ferromagnesium minerals in rocks.	A constituent of scale deposits in water pipes, boilers, and cookware. Second principal cause of water hardness.
Sodium (Na)	Sodium-bearing minerals in rocks; industrial wastes	Large concentrations in combination with chloride give water salty taste. Large concentrations in irrigation water may reduce soil permeability.
Potassium (K)	Potassium-bearing minerals in rocks; present in plant tissue, sewage, industrial wastes, and fertilizers.	Essential plant nutrient.
Bicarbonate (HCO_3) and carbonate (CO_3)	Carbon dioxide in air and soil atmosphere, "hardpan" deposits, or cementing material in sediments; also decomposition of organic matter in soil.	In combination with calcium and magnesium, cause carbonate hardness. Carbonates of calcium and magnesium form scale in steam boilers and hot-water facilities and release corrosive carbon dioxide gas.
Sulfate (SO_4)	Sulfide minerals in rocks, gypsum, precipitation, fertilizers, and sewage.	Sulfates of calcium and magnesium form hard scale. In concentrations greater than about 250 mg/L may have unpleasant taste and be cathartic to some individuals (National Academy of Sciences, 1974).
Chloride (Cl)	Soils and rocks, evaporite minerals, precipitation, animal wastes, and sewage.	Makes water corrosive; more than 250 mg/L may impart salty taste to water (National Academy of Sciences, 1974).
Fluoride (F)	Fluoride-bearing minerals which occur in trace amounts in most rocks.	Optimum concentrations tend to reduce decay of children's teeth; larger concentrations cause mottling of enamel of teeth. Concentration of fluoride in drinking water should not exceed 2 mg/L (U.S. Environmental Protection Agency, 1975).
Nitrate (NO_3) as N	Bacterial action in soil and plants; concentrated in plant and animal wastes, sewage, and fertilizers.	Essential plant nutrient. In surface water excessive nitrate and phosphates in combination cause algal blooms which may result in organic enrichment of water and depletion of dissolved oxygen. Consumption of water with more than about 10 mg/L of nitrate as N may cause methemoglobanemia in infants (U.S. Environmental Protection Agency, 1975). In excess of average concentrations may indicate pollution by organic wastes.
Phosphorus (P or phosphate (PO_4)	Phosphorus-bearing minerals present in most rocks in trace amounts. Component of sewage, animal wastes, fertilizers, and some detergents.	Essential plant nutrient. See nitrate.
Boron (B)	Boron-bearing minerals, volcanic gases, thermal springs, and sewage.	Essential in trace amounts to plant nutrition. In concentrations greater than about 2 mg/L, may be toxic even to tolerant crops (National Academy of Sciences, 1974).
Arsenic (As)	Dissolved from arsenic-bearing minerals. Ingredient of many herbicides and insecticides.	Prolonged consumption of water containing more than about 0.05 mg/L of arsenic may lead to chronic poisoning (U.S. Environmental Protection Agency, 1975).
Dissolved solids (residue on evaporation or calculated)		Measure of the concentration of dissolved solids in water.
Specific conductance		Indicator of the ability of a solute to conduct an electrical current. Gives indication of the concentration of dissolved solids in water.
Hardness as ($CaCO_3$)	Mainly dissolved calcium and magnesium in water.	Property of water related to the formation of an insoluble curd with soap and the formation of scale in pipes, boilers, and cooking utensils.
pH (hydrogen ion activity)	Hydrogen ions in solution.	Hydrogen ion activity expressed in negative logarithmic units. A measure of the dissociation of water molecules. A neutral solution has a pH of 7.0.
Temperature	Determined by local environment.	Important physical characteristic that affects taste, efficiency of waste-treatment processes, cooling, suitability of habitat for aquatic life, and suitability for irrigation.
SAR (sodium-adsorption-ratio)	Calculated from the following equation: $SAR = \frac{(Na^+)}{\sqrt{\frac{(Ca^{+2}) + (Mg^{+2})}{2}}}$ where: Na^{+2}, Ca^{+2}, Mg^{+2} are in milliequivalents per liter.	Equation predicts the degree to which irrigation water tends to enter into cation-exchange reactions in soil. High SAR values imply a hazard of sodium replacing adsorbed calcium and magnesium; this replacement is damaging to soil structure.

Table 5.--Chemical analyses of ground water in the Drewsey Resource Area

Sample number	Location number	Depth of well (feet)	Date of collection	Milligrams per liter: Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrite + nitrate as N	Phosphate, ortho as P	Arsenic (As)	Boron (B)	Dissolved solids, calculated from determined constituents	Hardness as $CaCO_3$	Noncarbonate hardness	Specific conductance (micromhos/cm at 25°C)	Sodium-adsorption-ratio (SAR)	pH	Temperature °F	Temperature °C
1	19S/36E-30daa	228	6- 8-77	56	0.02	0.00	7.4	4.5	12	4.8	76	0	3.5	1.3	0.1	0.47	0.06	0.001	0.007	129	37	0	145	0.9	6.8	66	19.0
2	20S/33½E-2adb	150	6- 7-77	60	.03	.09	23	7.7	19	7.4	130	0	21	5.3	.4	.26	.08	.01	.03	209	89	0	308	.9	7.2	54	12.0
3	21S/35E-13dbc	250	6- 9-77	37	.55	.18	34	9.1	63	12	130	0	120	4.1	.2	7.1	.05	0	.11	376	120	16	600	2.5	7.1	57	14.0
4	22S/34E-20bba	134	6-14-77	33	.26	.09	20	6.9	25	3.8	120	0	18	8.9	.4	2.4	.14	.004	.04	186	78	0	335	1.2	6.7	57	14.0
5	23S/37E-27dbd	75	6-10-77	48	.06	.01	34	13	62	6.2	190	0	69	27	.5	2.9	.13	.006	.30	367	140	0	600	2.3	7.1	57	14.0
6	25S/36E-16ccb(s)	--	6-28-77	370	.03	.00	2.7	.1	100	1.0	57	38	51	70	1.1	.24	.06	.095	2.2	1,360	7	0	650	16	9.1	106	41.0
7	26S/33E-26dcc	115	6-20-77	43	.31	.00	1.1	.1	140	1.2	250	35	27	17	1.0	1.3	.57	.023	.77	390	3	0	480	34	8.9	55	13.0
8	27S/31E-12cdc	152	6-21-77	40	.04	.00	25	13	37	4.6	210	0	11	8.1	.7	.51	.09	.004	.24	243	120	0	315	1.5	7.4	57	14.0
9	27S/32E-14bca	576	6-20-77	45	.08	.00	3.5	.5	130	3.6	270	0	5.6	36	1.7	.38	7.0	.003	.61	360	11	0	535	17	8.3	65	18.5
10	27S/32E-33acd	572	6-19-77	53	.03	.00	20	6.1	32	8.6	160	0	6.9	5.6	.8	1.4	.03	.024	.27	212	75	0	275	1.6	7.6	65	18.0
11	27S/34E-32cdc	163	6- -77	55	.13	.00	24	7.5	24	5.6	140	0	17	6.2	.4	1.0	.04	.012	.12	209	91	0	330	1.1	7.5	63	17.0
12	27S/35E-28ada	92	6-15-77	37	.03	.00	14	6.7	90	5.4	210	0	31	29	.7	.44	.14	.040	.98	320	63	0	775	5.0	7.7	54	12.0
13	28S/31E-1add	278	6-20-77	41	.02	.00	28	17	30	3.9	230	0	8.9	3.6	.3	2.9	.13	.002	.08	246	140	0	350	1.1	--	60	15.5
14	28S/33E-5dcd	578	6-17-77	59	.06	.01	25	4.5	47	9.6	150	0	36	16	.3	3.5	.02	.004	.14	272	81	0	440	2.3	7.5	68	20.0
15	28S/34E-30aaa	338	do	32	.09	.01	7.2	.4	34	3.1	92	0	10	3.7	.4	.08	.03	.048	.11	136	20	0	225	3.3	7.9	69	20.5
16	28S/36E-9cab	265	6-15-77	49	.08	.00	18	3.2	24	5.9	100	0	21	7.7	.3	--	.02	.001	.12	179	58	0	275	1.4	7.4	76	24.5

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE U.S. BUREAU OF LAND MANAGEMENT



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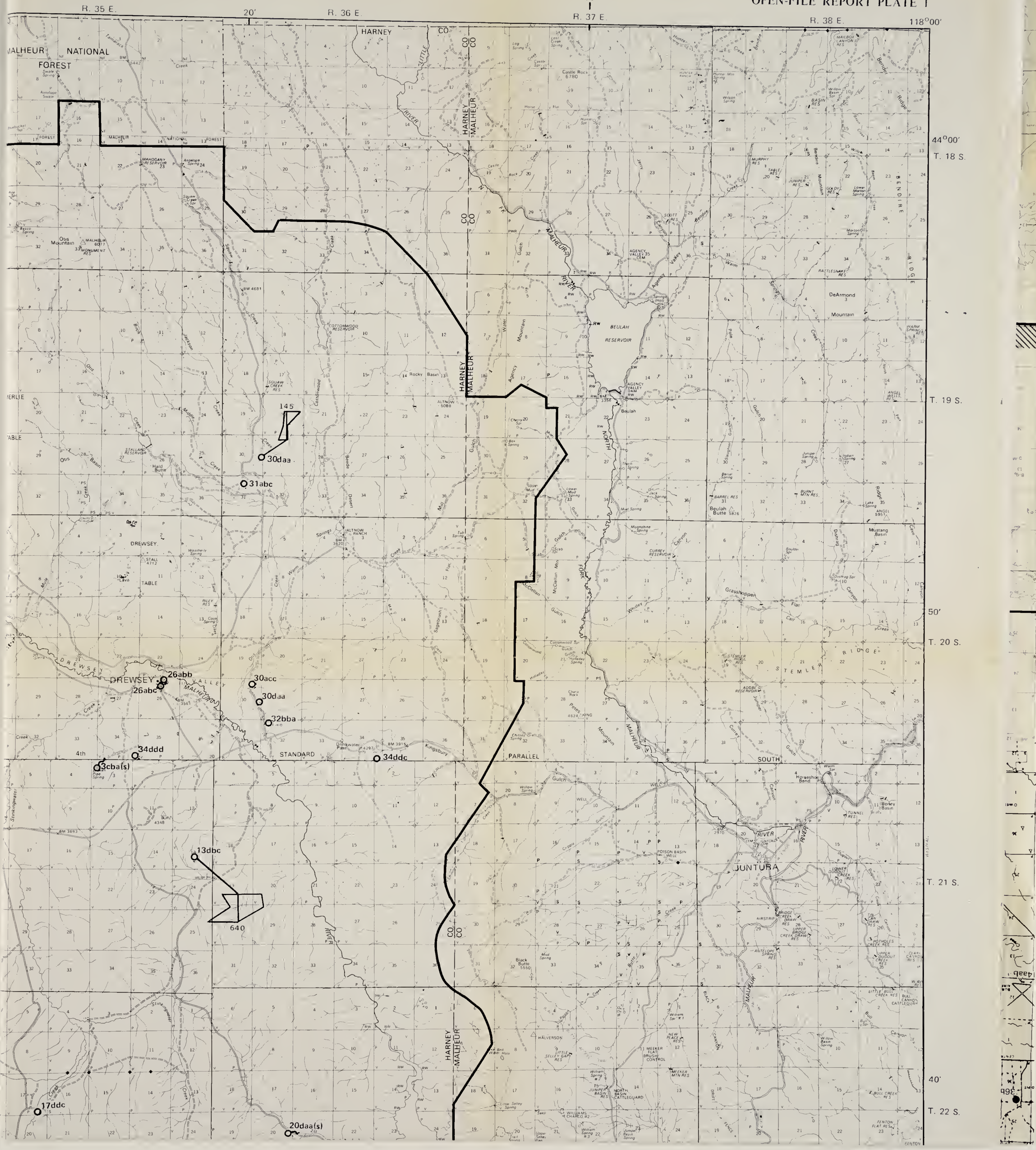
OPEN-FILE REPORT PLATE 1



T. 23 S.
T. 24 S.
T. 25 S.
T. 26 S.
T 27 S.
43°30'
20'
10'
BURNS
HINES
CRANE
NEW PRINCETON
HARNEY LAKE
MALHEUR
NATIONAL
WILDLIFE
REFUGE
M A L H E U R
N A T I O N A L
L A K E
W I L D L I F E
R E F U G E
STANDARD
PARALLEL
SUNSET VALLEY
R 30 E
R 31 E
335
480
535
315
27ddc
28dda
34ccb
3bbb
5ajc
36bab
30cdb
3aad
1bbb
27adc
11dcc1,2
14aab
7cab
16bcc
16dbb
28aba
29adb
30ddd
31add
36add
31add
36bbc
33cbc
4cdd
28bcc
30ddc
26ddc
4cba
31bac
31cbd
31dcb
29ccb
30dcc
6acd
6dab
11dcd
13daa
21cbb
19ccc
19ddc
19cab
19dba
25cba
28cdb
28dcb
33baa
26dcc
34acc
34cca
2bbb
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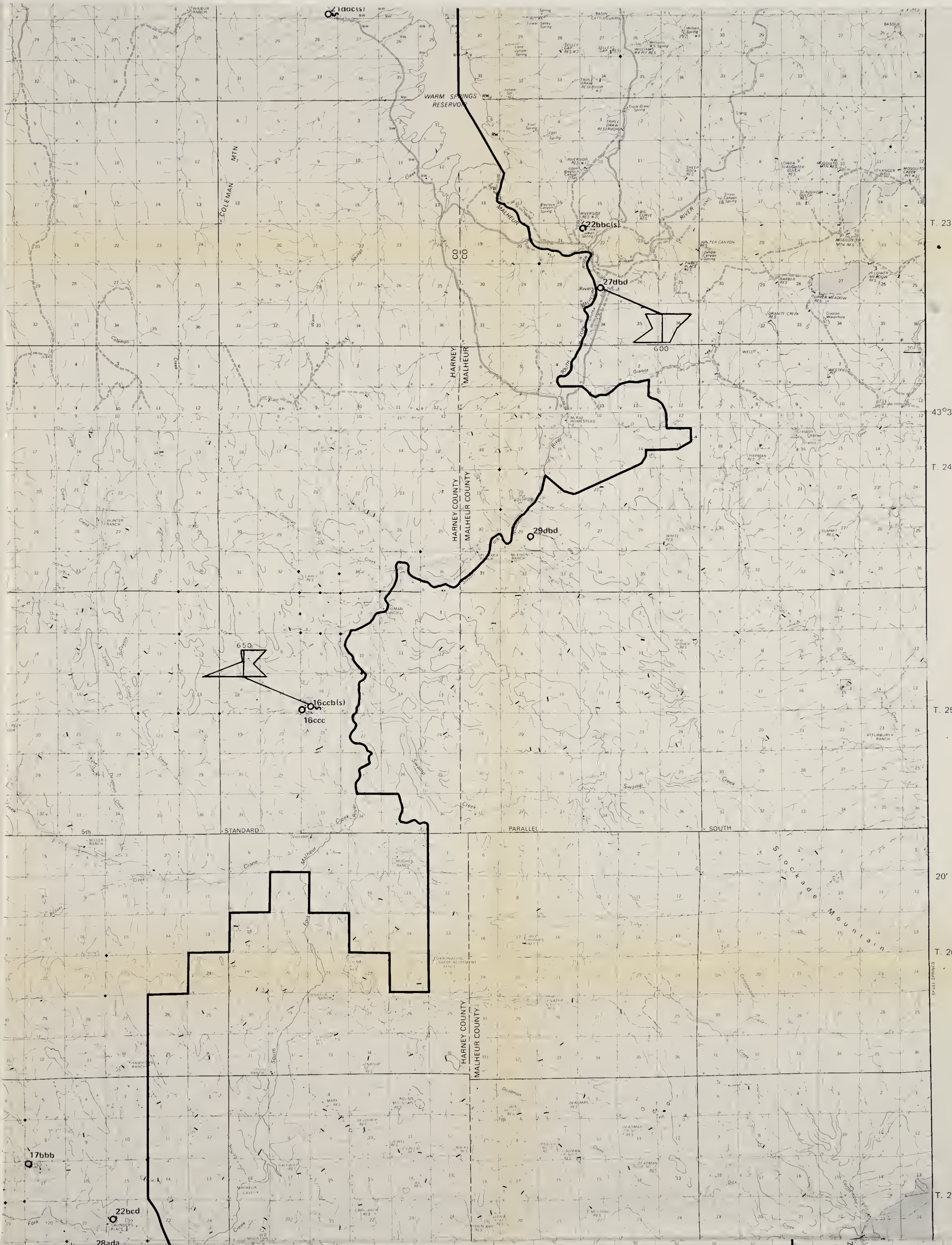


1dac(s)
WARM SPRINGS RESERVOIR
COLEMAN MTN
MALHEUR
RIVER
22bbc(s)
27dbd
600
HARNEY
MALHEUR
HARNEY COUNTY
MALHEUR COUNTY
29dbd
650
16ccb(s)
16ccc
T. 23 S.
43°30′
T. 24 S.
T. 25 S.
5th
STANDARD
PARALLEL
SOUTH
20′
Stockade Mountain
T. 26 S.
HARNEY COUNTY
MALHEUR COUNTY
17bbb
22bcd
28ada
T. 27 S.

EXPLANATION

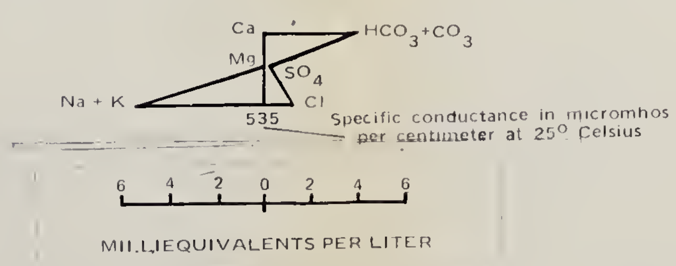
13dbc ○ Well – Location number shown. (See text for explanation)

27adc ● Observation well.

3cba(s) Spring – Location number shown. (See text for explanation)

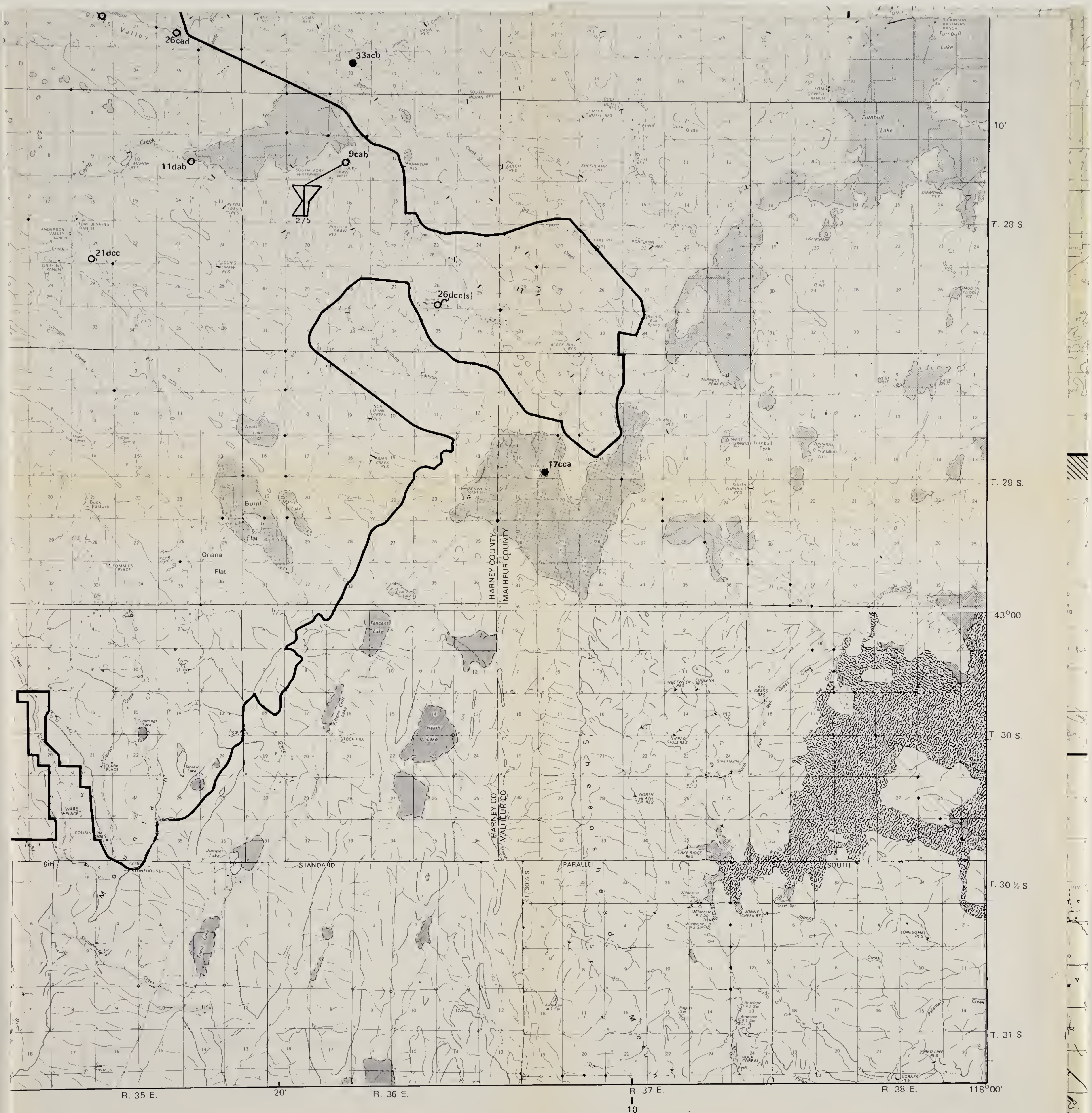
Area covered by Ground-Water Report No. 16, Oregon State Engineer, 1970.

Boundary of Drewsey Resource Area.



Chemical diagram showing concentrations of major ions in ground-water samples

WELL AND SPRING LOCATIONS AND GROUND-WATER CHEMICAL DIAGRAMS FOR THE DREWSEY RESOU



RCE AREA, HARNEY AND MALHEUR COUNTIES, OREGON